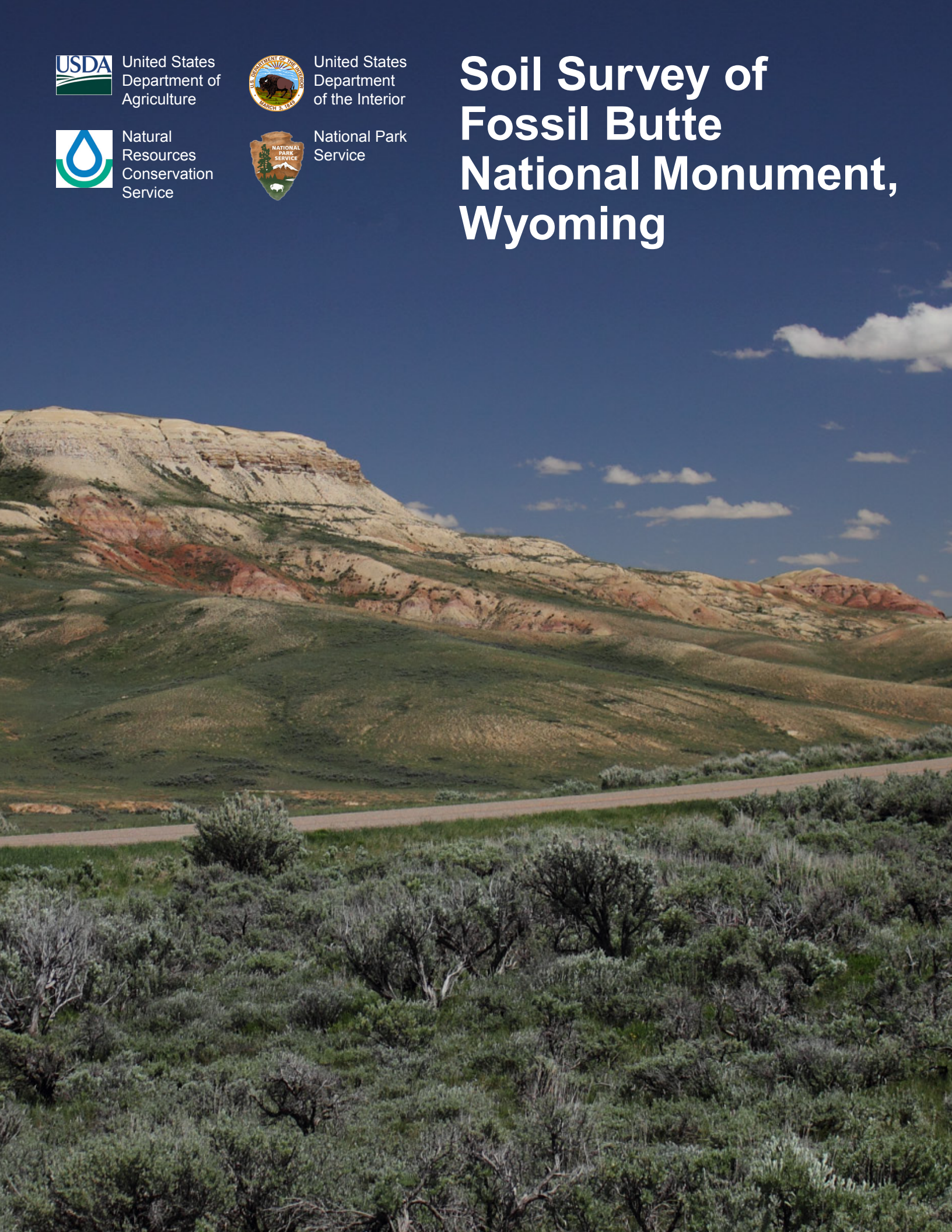
United States Department of Agriculture

United States Department of the Interior

Natural Resources Conservation Service

National Park Service

Soil Survey of Fossil Butte National Monument, Wyoming



How To Use This Soil Survey

This publication consists of text, tables, and a map. The text includes descriptions of detailed soil map units and provides an explanation of the information presented in the tables. It also includes a glossary of terms used in the text and tables and a list of references.

The detailed soil map can be useful in planning the use and management of small areas. To find information about your area of interest, locate that area on the map sheet. Note the map unit symbols that are in that area. Go to the Contents, which lists the map units by symbol and name and shows where each map unit is described.

The Contents shows which table has data on a specific land use for each detailed soil map unit. Also see the Contents for sections of this publication that may address your specific needs.

National Cooperative Soil Survey

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 2015. Soil names and descriptions were approved in 2014. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 2014. This survey was made cooperatively by the Natural Resources Conservation Service and the National Park Service.

The soil map in this survey may be copied without permission. Enlargement of this map, however, could cause misunderstanding of the detail of mapping. If enlarged, the map does not show the small areas of contrasting soils that could have been shown at a larger scale.

Literature Citation

The correct citation for this survey is as follows:

United States Department of Agriculture, Natural Resources Conservation Service, and United States Department of the Interior, National Park Service. 2015. Soil survey of Fossil Butte National Monument, Wyoming. (Accessible online at: http://soils.usda.gov/survey/printed_surveys/)

Cover Caption

Areas of slope alluvium in the foreground are in map unit Mantlemine-Gunsone complex, 3 to 15 percent slopes. These areas are vegetated with a mix of basin big sagebrush and Wyoming big sagebrush. Fossil Butte (in the distance, at left) is underlain by the Wasatch Formation, from which Ulric, Wiscow, and Gunsone soils developed.

Additional information about the Nation's natural resources is available online from the Natural Resources Conservation Service at http://www.nrcs.usda.gov/.

Nondiscrimination Statement

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases will apply to all programs and/or employment activities.)

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by email to program.intake@usda.gov or by mail to:

USDA
Office of the Assistant Secretary for Civil Rights
1400 Independence Avenue, S.W.
Washington, D.C. 20250-9410

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Contents

Issued 2015

Preface

This soil survey was developed in conjunction with the National Park Service's Soil Inventory and Monitoring Program and is intended to serve as the official source document for soils occurring within Fossil Butte National Monument, Wyoming.

This soil survey contains information that affects current and future land use planning in the park. It contains predictions of soil behavior for selected land uses. The survey highlights soil limitations, actions needed to overcome the limitations, and the impact of selected land uses on the environment. It is designed to meet the needs of the National Park Service and its partners to better understand the properties of the soils in the park and the effects of these properties on various natural ecological characteristics. This knowledge can help the National Park Service and its partners to understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. The location of each map unit is shown on the detailed soil map. Each soil in the survey area is described, and information on specific uses is given. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the park office for Fossil Butte National Monument.

Soil Survey of
Fossil Butte National Monument, Wyoming

United States Department of Agriculture, Natural Resources Conservation Service, and United States Department of the Interior, National Park Service

How This Survey Was Made

This survey was made in conjunction with the National Park Service's Soil Inventory and Monitoring Program to provide information about the soils and miscellaneous areas within Fossil Butte National Monument.

The soil survey for the park was clipped from the soil survey of Lincoln County, Wyoming, southern part, which is still in progress as of 2015. The final correlation for the county has not yet been completed. Mapping was performed at a scale of 1:24,000. The soils data is being progressively posted to the Soil Data Mart. At the time this document was assembled (December 2013), there were 13 different map units comprised of 49 map unit components within the area of Fossil Butte National Monument. Seven new series were established in the park: Cundick, Ducktail, Fossilbutte, Gunsone, Quakenasp, Swiftcreek, and Ulric.

During the soil survey, ecological sites and soil component relationships were observed. Soil-site correlation concepts were established to help in designing the map units. Soil and plant specialists tested the concepts during mapping and collected field documentation at numerous points across the landscape. Ecological sites were assigned to most, but not all, of the soil components in each map unit.

The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general patterns of drainage; the kinds of native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only

a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units).

Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil Taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they delineated the boundaries of these bodies on digital imagery and identified each as a specific map unit.

Detailed Soil Map Units

The map units delineated on the detailed soil map in this survey represent the soils or miscellaneous areas in the park. The map unit descriptions in this section, along with the map, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the map. The contrasting components are mentioned in the map unit descriptions. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. The soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of

the areas shown on the detailed soil map are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Gerdrum clay loam, 3 to 10 percent slopes, is a phase of the Gerdrum series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the map. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Mantlemine-Gunsone complex, 3 to 15 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Table 1 gives the acreage and number of hectares of each map unit. Other tables give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

85C—Gerdrum clay loam, 3 to 10 percent slopes

Map Unit Setting

General setting: Intermontane basins
Major land resource area: 34A—Cool Central Desertic Basins and Plateaus
Elevation: 2,000.0 to 2,100 meters
Mean annual precipitation: 275 to 325 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 60 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Gerdrum and similar soils: 90 percent
Dissimilar minor components: 10 percent

Description of the Gerdrum Soil

Taxonomic Classification
Fine, smectitic, frigid Torrertic Natrustalfs

Setting
Landform: Alluvial fans
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): Southwest
Aspect range: Southeast to west (clockwise)
Slope range: 3 to 10 percent
Parent material: Alluvium derived from shale and siltstone

Properties and Qualities
Depth to restrictive feature: 15 to 25 centimeters to natric horizon
Shrink-swell potential: High (about 6.6 LEP)
Salinity maximum based on representative value: Moderately saline (about 12.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 18.0
Calcium carbonate equivalent percent: 20

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 28.1 centimeters)

Typical Profile
AE—0 to 7 centimeters; clay loam
Bt—7 to 20 centimeters; clay
Btn—20 to 60 centimeters; clay
Btkny—60 to 85 centimeters; clay
BCky—85 to 120 centimeters; clay
C—120 to 203 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated and irrigated areas): 6s
Ecological site name and ID: Saline Upland (Foothills And Basins West) (R034AY244WY)
Hydric soil status: No
Hydrologic soil group: D

Minor Components

Redsage soils
Percent of map unit: 10 percent
Slope: 3 to 10 percent
Landform: Swales on alluvial fans
Ecological site name and ID: Loamy (Foothills And Basins West) (R034AY222WY)
Hydric soil status: No

161—Rock outcrop

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills

Map Unit Composition

Rock outcrop: 100 percent

General Description

Rock outcrop in the survey area consists of bedrock exposures of limestone, shale, and sandstone.

2564—Badland-Ulric-Gunsone complex, 15 to 30 percent slopes

Map Unit Setting

Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,040.0 to 2,240 meters
Mean annual precipitation: 275 to 325 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 60 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Badland: 45 percent
Ulric and similar soils: 30 percent
Gunsone and similar soils: 15 percent
Dissimilar minor components: 10 percent

Description of Badland

Badland consists of steep exposures of weathered and unweathered shale with little or no vegetation.

Description of the Ulric Soil

Taxonomic Classification

Fine, smectitic, frigid Torrertic Haplustalfs

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear, concave
Aspect (representative): South
Aspect range: South to west (clockwise)
Slope range: 15 to 30 percent
Parent material: Colluvium derived from sedimentary rock over residuum weathered from shale

Properties and Qualities

Depth to restrictive feature: 75 to 105 centimeters to paralithic bedrock
Shrink-swell potential: Moderate (about 5.4 LEP)
Salinity maximum based on representative value: Slightly saline (about 6.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 15

Hydrologic Properties

Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Low (about 12.8 centimeters)

Typical Profile

A—0 to 15 centimeters; loam
Btk—15 to 45 centimeters; clay loam
BCk—45 to 90 centimeters; parachannery clay
Cr—90 to 200 centimeters; bedrock

Interpretive Groups

Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Shallow Clayey (Foothills And Basins West) (R034AY258WY)
Hydric soil status: No
Hydrologic soil group: C

Description of the Gunsone Soil

Taxonomic Classification
Fine, smectitic, frigid Torrertic Haplustalfs

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): South
Aspect range: South to west (clockwise)
Slope range: 15 to 30 percent
Parent material: Colluvium over residuum weathered from shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 7.0 LEP)
Salinity maximum based on representative value: Moderately saline (about 12.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 15

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 26.7 centimeters)

Typical Profile
A—0 to 11 centimeters; loam
Bt—11 to 30 centimeters; clay loam
Btk—30 to 75 centimeters; clay
BCky—75 to 100 centimeters; clay
C—100 to 203 centimeters; paragravelly clay loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Dense Clay (Foothills And Basins West) (R034AY210WY)
Hydric soil status: No
Hydrologic soil group: C

Minor Components

Mantlemine soils
Percent of map unit: 5 percent
Slope: 10 to 20 percent
Landform: Hills
Ecological site name and ID: Loamy (Foothills And Basins West) (R034AY222WY)
Hydric soil status: No

Redsage soils
Percent of map unit: 5 percent
Slope: 5 to 15 percent

Landform: Drainageways on hills
Ecological site name and ID: Overflow (Foothills And Basins West) (R034AY230WY)
Hydric soil status: No

2571E—Cundick-Fossilbutte-Swiftcreek complex, 6 to 20 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,286.0 to 2,438 meters
Mean annual precipitation: 325 to 500 millimeters
Mean annual air temperature: 3 to 5 degrees C
Frost-free period: 30 to 60 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Cundick and similar soils: 45 percent
Fossilbutte and similar soils: 25 percent
Swiftcreek and similar soils: 15 percent
Dissimilar minor components: 15 percent

Description of the Cundick Soil

Taxonomic Classification
Fine-loamy, mixed, superactive Ustic Haplocryalfs

Setting
Landform: Ridges and buttes
Landform position (three-dimensional): Interfluve and tread
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 6 to 20 percent
Parent material: Slope alluvium over residuum weathered from limestone

Properties and Qualities
Depth to restrictive feature: 75 to 95 centimeters to lithic bedrock
Shrink-swell potential: Low (about 2.3 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 20

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Low (about 10.9 centimeters)

Typical Profile
A—0 to 12 centimeters; gravelly loam
Btk—12 to 48 centimeters; gravelly clay loam

Bk—48 to 85 centimeters; gravelly loam
R—85 to 203 centimeters; bedrock

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Shallow Clayey (Foothills And Basins West) (R034AY258WY)
Hydric soil status: No
Hydrologic soil group: C

Description of the Fossilbutte Soil

Taxonomic Classification
Fine, smectitic Vertic Haplocryalfs

Setting
Landform: Mesas and ridges
Landform position (three-dimensional): Interfluve and tread
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 6 to 20 percent
Parent material: Slope alluvium derived from sedimentary rock

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 6.8 LEP)
Salinity maximum based on representative value: Very slightly saline (about 3.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 1.0
Calcium carbonate equivalent percent: 10

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 28.8 centimeters)

Typical Profile
A—0 to 7 centimeters; clay loam
Bt1—7 to 15 centimeters; clay loam
Bt2—15 to 80 centimeters; clay
Btk—80 to 200 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Mountain Shallow Loam (Low Sagebrush) (R047XA442UT)
Hydric soil status: No
Hydrologic soil group: C

Description of the Swiftcreek Soil

Taxonomic Classification
Fine-loamy, mixed, superactive Ustic Haplocryepts

Setting
Landform: Rotational slides
Landform position (three-dimensional): Nose slope
Down-slope shape: Convex
Across-slope shape: Concave
Aspect (representative): North
Aspect range: All aspects
Slope range: 6 to 20 percent
Parent material: Slide deposits derived from limestone

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Low (about 1.8 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 40

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 23.0 centimeters)

Typical Profile
A—0 to 10 centimeters; gravelly loam
Bw—10 to 65 centimeters; gravelly loam
C—65 to 203 centimeters; very gravelly loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Coarse Upland (Foothills And Basins West) (R034AY208WY)
Hydric soil status: No
Hydrologic soil group: B

Minor Components

Reppart soils
Percent of map unit: 10 percent
Slope: 6 to 20 percent
Landform: Mesas and ridges
Ecological site name and ID: Mountain Loam (Browse) (R047XA420UT)
Hydric soil status: No

Rock outcrop
Percent of map unit: 5 percent

10001—Quakenasp-Ducktail complex, 20 to 80 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,194.6 to 2,377 meters

Mean annual precipitation: 375 to 500 millimeters
Mean annual air temperature: 3 to 7 degrees C
Frost-free period: 20 to 80 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Quakenasp and similar soils: 50 percent
Ducktail and similar soils: 35 percent
Dissimilar minor components: 15 percent

Description of the Quakenasp Soil

Taxonomic Classification
Fine, smectitic Vertic Argicryolls

Setting
Landform: Hills
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope and head slope
Down-slope shape: Linear, concave
Across-slope shape: Concave
Aspect (representative): North
Aspect range: Northwest to northeast (clockwise)
Slope range: 20 to 35 percent
Parent material: Colluvium derived from limestone over residuum weathered from shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Moderate (about 5.3 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 15

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Very high (about 35.6 centimeters)

Typical Profile
Oe—0 to 8 centimeters; moderately decomposed plant material
A—8 to 35 centimeters; loam
Btk—35 to 85 centimeters; clay loam
2C—85 to 200 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Populus tremuloides/Symphoricarpos oreophilus/Bromus carinatus (F047XA508UT)
Hydric soil status: No
Hydrologic soil group: C

Description of the Ducktail Soil

Taxonomic Classification
Coarse-loamy, mixed, superactive Typic Haplocryolls

Setting
Landform: Escarpments
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: Northwest to northeast (clockwise)
Slope range: 60 to 80 percent
Parent material: Colluvium derived from limestone

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Low (about 0.8 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Sodium adsorption ratio is about 1.0
Calcium carbonate equivalent percent: 25

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): High
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 24.8 centimeters)

Typical Profile
Oi—0 to 10 centimeters; slightly decomposed plant material
A—10 to 18 centimeters; gravelly sandy loam
Bw—18 to 40 centimeters; gravelly sandy loam
C—40 to 200 centimeters; sandy loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 7e
Ecological site name and ID: Pseudotsuga menziesii/Mahonia/Bromus (F047XA532UT)
Hydric soil status: No
Hydrologic soil group: A

Minor Components

Swiftcreek soils
Percent of map unit: 10 percent
Slope: 20 to 40 percent
Landform: Rotational slides
Ecological site name and ID: Mountain Loam (Browse) (R047XA420UT)
Hydric soil status: No

Rock outcrop
Percent of map unit: 5 percent

10003—Mantlemine-Gunsone complex, 3 to 15 percent slopes

Map Unit Setting

General setting: Intermontane basins
Major land resource area: 34A—Cool Central Desertic Basins and Plateaus

Elevation: 2,011.7 to 2,195 meters
Mean annual precipitation: 275 to 330 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 60 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Mantlemine and similar soils: 50 percent
Gunsone and similar soils: 30 percent
Dissimilar minor components: 20 percent

Description of the Mantlemine Soil

Taxonomic Classification
Fine-loamy, mixed, superactive, frigid Calcidic Haplustalfs

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear, concave
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 3 to 15 percent
Parent material: Slope alluvium over residuum weathered from sandstone and shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Moderate (about 3.8 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 25

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Very high (about 34.5 centimeters)

Typical Profile
A—0 to 7 centimeters; loam
BA—7 to 24 centimeters; loam
Bt—24 to 60 centimeters; clay loam
Btk—60 to 80 centimeters; clay loam
Bk—80 to 110 centimeters; loam
BCk—110 to 140 centimeters; loam
C—140 to 203 centimeters; loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Loamy (Foothills And Basins West) (R034AY222WY)
Hydric soil status: No
Hydrologic soil group: B

Description of the Gunsone Soil

Taxonomic Classification
Fine, smectitic, frigid Torrertic Haplustalfs

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Nose slope
Down-slope shape: Linear
Across-slope shape: Convex
Aspect (representative): North
Aspect range: All aspects
Slope range: 3 to 8 percent
Parent material: Slope alluvium over residuum weathered from shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 7.0 LEP)
Salinity maximum based on representative value: Moderately saline (about 12.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 15

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 26.7 centimeters)

Typical Profile
A—0 to 11 centimeters; loam
Btk1—11 to 30 centimeters; clay loam
Btk2—30 to 75 centimeters; clay
BCkyz—75 to 100 centimeters; clay
C—100 to 203 centimeters; paragravelly clay loam

Interpretive Groups
Land capability subclass: Nonirrigated areas—6s; irrigated areas—6e
Ecological site name and ID: Dense Clay (Foothills And Basins West) (R034AY210WY)
Hydric soil status: No
Hydrologic soil group: C

Minor Components

Dunlap soils
Percent of map unit: 10 percent
Slope: 3 to 7 percent
Landform: Hills
Ecological site name and ID: Shallow Loamy (Foothills And Basins West) (R034AY262WY)
Hydric soil status: No

Redsage soils
Percent of map unit: 10 percent
Slope: 3 to 15 percent

Landform: Drainageways on hills
Ecological site name and ID: Overflow (Foothills And Basins West) (R034AY230WY)
Hydric soil status: No

10004—Gunsone loam, 3 to 15 percent slopes

Map Unit Setting

General setting: Intermontane basins
Major land resource area: 34A—Cool Central Desertic Basins and Plateaus
Elevation: 2,011.7 to 2,195 meters
Mean annual precipitation: 275 to 330 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 60 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Gunsone and similar soils: 80 percent
Dissimilar minor components: 20 percent

Description of the Gunsone Soil

Taxonomic Classification
Fine, smectitic, frigid Torrertic Haplustalfs

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): South
Aspect range: Southeast to west (clockwise)
Slope range: 3 to 15 percent
Parent material: Slope alluvium over residuum weathered from shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 7.0 LEP)
Salinity maximum based on representative value: Moderately saline (about 12.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 15

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 26.7 centimeters)

Typical Profile
A—0 to 11 centimeters; loam
Btk1—11 to 30 centimeters; clay loam
Btk2—30 to 75 centimeters; clay

BCkyz—75 to 100 centimeters; clay
C—100 to 203 centimeters; paragravelly clay loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6s
Ecological site name and ID: Dense Clay (Foothills And Basins West) (R034AY210WY)
Hydric soil status: No
Hydrologic soil group: C

Minor Components

Mantlemine soils
Percent of map unit: 10 percent
Slope: 3 to 15 percent
Landform: Drainageways on hills
Ecological site name and ID: Loamy (Foothills And Basins West) (R034AY222WY)
Hydric soil status: No

Whitesage soils
Percent of map unit: 10 percent
Slope: 3 to 9 percent
Landform: Hills
Ecological site name and ID: Shallow Loamy (Foothills And Basins West) (R034AY262WY)
Hydric soil status: No

10005—Babb loam, 10 to 25 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,194.6 to 2,377 meters
Mean annual precipitation: 350 to 450 millimeters
Mean annual air temperature: 3 to 7 degrees C
Frost-free period: 30 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Babb and similar soils: 80 percent
Dissimilar minor components: 20 percent

Description of the Babb Soil

Taxonomic Classification
Fine-loamy, mixed, superactive Calcic Haplocryolls

Setting
Landform: Rotational slides
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Concave
Aspect (representative): South
Aspect range: South to west (clockwise)
Slope range: 10 to 25 percent
Parent material: Slide deposits derived from limestone over residuum weathered from shale and siltstone

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 6.2 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 25

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Moderately well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: About 110 to 150 centimeters (see table 18)
Available water capacity (entire profile): Very high (about 31.9 centimeters)

Typical Profile
A—0 to 25 centimeters; loam
Bk—25 to 80 centimeters; gravelly loam
BCk—80 to 130 centimeters; gravelly loam
2C—130 to 203 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Populus tremuloides/Symphoricarpos oreophilus/Bromus carinatus (F047XA508UT)
Hydric soil status: No
Hydrologic soil group: B

Minor Components

Cundick soils
Percent of map unit: 10 percent
Slope: 10 to 25 percent
Landform: Escarpments
Ecological site name and ID: Loamy (Foothills And Mountains West) (R043BY222WY)
Hydric soil status: No

Rock outcrop
Percent of map unit: 5 percent

Swiftcreek soils
Percent of map unit: 5 percent
Slope: 10 to 25 percent
Landform: Rotational slides
Ecological site name and ID: Coarse Upland (Foothills And Basins West) (R034AY208WY)
Hydric soil status: No

10006—Chickenhill-Gunsone complex, 10 to 30 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,072.6 to 2,377 meters
Mean annual precipitation: 300 to 350 millimeters

Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 60 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Chickenhill and similar soils: 45 percent
Gunsone and similar soils: 35 percent
Dissimilar minor components: 20 percent

Description of the Chickenhill Soil

Taxonomic Classification
Fine-loamy, mixed, superactive, frigid Aridic Calciustepts

Setting
Landform: Hills
Landform position (two-dimensional): Shoulder and backslope
Landform position (three-dimensional): Nose slope and side slope
Down-slope shape: Linear
Across-slope shape: Linear, convex
Aspect (representative): Southwest
Aspect range: Southeast to west (clockwise)
Slope range: 10 to 30 percent
Parent material: Slope alluvium over residuum weathered from shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Moderate (about 3.8 LEP)
Salinity maximum based on representative value: Very slightly saline (about 3.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 22

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Very high (about 32.7 centimeters)

Typical Profile
A—0 to 8 centimeters; loam
Bw—8 to 22 centimeters; loam
Bk—22 to 65 centimeters; gravelly loam
C—65 to 200 centimeters; silty clay loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Shallow Clayey (Foothills And Basins West) (R034AY258WY)
Hydric soil status: No
Hydrologic soil group: C

Description of the Gunsone Soil

Taxonomic Classification
Fine, smectitic, frigid Torrertic Haplustalfs

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): Southwest
Aspect range: Southeast to west (clockwise)
Slope range: 10 to 30 percent
Parent material: Slope alluvium over residuum weathered from shale

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 7.0 LEP)
Salinity maximum based on representative value: Moderately saline (about 12.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 15

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 26.7 centimeters)

Typical Profile
A—0 to 11 centimeters; loam
Btk1—11 to 30 centimeters; clay loam
Btk2—30 to 75 centimeters; clay
BCkyz—75 to 100 centimeters; clay
C—100 to 203 centimeters; paragravelly clay loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Dense Clay (Foothills And Basins West) (R034AY210WY)
Hydric soil status: No
Hydrologic soil group: C

Minor Components

Mantlemine soils
Percent of map unit: 10 percent
Slope: 3 to 15 percent
Landform: Drainageways on hills
Ecological site name and ID: Loamy (Foothills And Basins West) (R034AY222WY)
Hydric soil status: No

Rock outcrop
Percent of map unit: 5 percent

Swiftcreek soils
Percent of map unit: 5 percent
Slope: 10 to 40 percent
Landform: Rotational slides

Ecological site name and ID: Coarse Upland (Foothills And Basins West) (R034AY208WY)
Hydric soil status: No

10007—Swiftcreek gravelly loam, 15 to 50 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,194.6 to 2,377 meters
Mean annual precipitation: 325 to 450 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 60 to 90 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Swiftcreek and similar soils: 75 percent
Dissimilar minor components: 25 percent

Description of the Swiftcreek Soil

Taxonomic Classification
Fine-loamy, mixed, superactive, frigid Typic Haplustepts

Setting
Landform: Rotational slides
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Aspect (representative): North
Aspect range: All aspects
Slope range: 15 to 50 percent
Parent material: Slide deposits derived from limestone

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Low (about 1.8 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 40

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 23.0 centimeters)

Typical Profile
A—0 to 10 centimeters; gravelly loam
Bw—10 to 65 centimeters; gravelly loam
C—65 to 203 centimeters; very gravelly loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 7e

Ecological site name and ID: Coarse Upland (Foothills And Basins West) (R034AY208WY)
Hydric soil status: No
Hydrologic soil group: B

Minor Components

Lithic Ustorthents
Percent of map unit: 10 percent
Slope: 15 to 50 percent
Landform: Escarpments
Ecological site name and ID: Shallow Loamy (Foothills And Basins West) (R034AY262WY)
Hydric soil status: No

Marigold soils
Percent of map unit: 10 percent
Slope: 15 to 50 percent
Landform: Escarpments
Ecological site name and ID: Loamy (Foothills And Mountains West) (R043BY222WY)
Hydric soil status: No

Rock outcrop
Percent of map unit: 5 percent

10008—Cundick-Fossilbutte complex, 1 to 6 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 2,286.0 to 2,438 meters
Mean annual precipitation: 325 to 500 millimeters
Mean annual air temperature: 3 to 5 degrees C
Frost-free period: 30 to 60 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Cundick and similar soils: 40 percent
Fossilbutte and similar soils: 35 percent
Dissimilar minor components: 25 percent

Description of the Cundick Soil

Taxonomic Classification
Fine-loamy, mixed, superactive Ustic Haplocryalfs

Setting
Landform: Mesas and ridges
Landform position (three-dimensional): Interfluve and tread
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 1 to 6 percent
Parent material: Slope alluvium over residuum weathered from limestone

Properties and Qualities
Depth to restrictive feature: 75 to 95 centimeters to lithic bedrock
Shrink-swell potential: Low (about 2.3 LEP)
Salinity maximum based on representative value: Nonsaline (about 1.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 20

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Low (about 10.9 centimeters)

Typical Profile
A—0 to 12 centimeters; gravelly loam
Btk—12 to 48 centimeters; gravelly clay loam
Bk—48 to 85 centimeters; gravelly loam
R—85 to 203 centimeters; bedrock

Interpretive Groups
Land capability subclass (nonirrigated and irrigated areas): 6e
Ecological site name and ID: Mountain Loam (Browse) (R047XA420UT)
Hydric soil status: No
Hydrologic soil group: C

Description of the Fossilbutte Soil

Taxonomic Classification
Fine, smectitic Vertic Haplocryalfs

Setting
Landform: Mesas and ridges
Landform position (three-dimensional): Interfluve and tread
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 1 to 6 percent
Parent material: Slope alluvium derived from sedimentary rock

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 6.8 LEP)
Salinity maximum based on representative value: Very slightly saline (about 3.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 1.0
Calcium carbonate equivalent percent: 10

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): High (about 28.8 centimeters)

Typical Profile
A—0 to 7 centimeters; clay loam
Bt1—7 to 15 centimeters; clay loam
Bt2—15 to 80 centimeters; clay
Btk—80 to 200 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated and irrigated areas): 6e
Ecological site name and ID: Mountain Shallow Loam (Low Sagebrush) (R047XA442UT)
Hydric soil status: No
Hydrologic soil group: C

Minor Components

Ettienridge soils
Percent of map unit: 10 percent
Slope: 1 to 6 percent
Landform: Mesas and ridges
Ecological site name and ID: Gravelly (Foothills And Basins West) (R034AY212WY)
Hydric soil status: No

Reppart soils
Percent of map unit: 10 percent
Slope: 1 to 6 percent
Landform: Mesas and ridges
Ecological site name and ID: Mountain Loam (Browse) (R047XA420UT)
Hydric soil status: No

Lyonsbridge soils
Percent of map unit: 5 percent
Slope: 1 to 6 percent
Landform: Mesas and ridges
Ecological site name and ID: Semidesert Silt Loam (Winterfat) (R047XB244UT)
Hydric soil status: No

10012—Redsage-Rootel complex, 8 to 35 percent slopes

Map Unit Setting

General setting: Foothills
Major land resource area: 46—Northern Rocky Mountain Foothills
Elevation: 1,981.2 to 2,195 meters
Mean annual precipitation: 250 to 355 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 50 to 80 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Redsage and similar soils: 65 percent
Rootel and similar soils: 30 percent
Dissimilar minor components: 5 percent

Description of the Redsage Soil

Taxonomic Classification
Fine-loamy, mixed, superactive, frigid Aridic Calciustepts

Setting
Landform: Rotational slides
Landform position (two-dimensional): Summit and backslope
Landform position (three-dimensional): Interfluve and side slope
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): South
Aspect range: Southeast to west (clockwise)
Slope range: 8 to 20 percent
Parent material: Slide deposits derived from sedimentary rock

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: Moderate (about 3.1 LEP)
Salinity maximum based on representative value: Very slightly saline (about 3.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 20

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Very high (about 32.1 centimeters)

Typical Profile
A—0 to 10 centimeters; loam
Bk1—10 to 32 centimeters; loam
Bk2—32 to 80 centimeters; gravelly clay loam
Bk3—80 to 105 centimeters; clay loam
C—105 to 203 centimeters; clay loam

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Loamy (Foothills And Basins West) (R034AY222WY)
Hydric soil status: No
Hydrologic soil group: B

Description of the Rootel Soil

Taxonomic Classification
Fine-loamy, mixed, superactive, frigid Aridic Calciustepts

Setting
Landform: Rotational slides
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Nose slope and side slope
Down-slope shape: Convex
Across-slope shape: Linear
Aspect (representative): South
Aspect range: Southeast to west (clockwise)
Slope range: 15 to 35 percent
Parent material: Slide deposits derived from sedimentary rock over residuum weathered from calcareous sandstone

Properties and Qualities
Depth to restrictive feature: 85 to 105 centimeters to paralithic bedrock
Shrink-swell potential: Low (about 2.3 LEP)
Salinity maximum based on representative value: Very slightly saline (about 3.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 7.0
Calcium carbonate equivalent percent: 20

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately high
Natural drainage class: Well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: None within 160 centimeters
Available water capacity (entire profile): Low (about 13.0 centimeters)

Typical Profile
A—0 to 9 centimeters; loam
Bk1—9 to 40 centimeters; gravelly loam
Bk2—40 to 75 centimeters; gravelly loam
2BCk—75 to 95 centimeters; loam
2Cr—95 to 203 centimeters; bedrock

Interpretive Groups
Land capability subclass (nonirrigated areas): 6e
Ecological site name and ID: Shallow Loamy (Foothills And Basins West) (R034AY262WY)
Hydric soil status: No
Hydrologic soil group: C

Minor Components

Rock outcrop
Percent of map unit: 5 percent

10014—Absher-Bearbou complex, 0 to 3 percent slopes

Map Unit Setting

General setting: Intermontane basins
Major land resource area: 34A—Cool Central Desertic Basins and Plateaus
Elevation: 1,981.2 to 2,134 meters
Mean annual precipitation: 275 to 350 millimeters
Mean annual air temperature: 5 to 7 degrees C
Frost-free period: 50 to 80 days
Farmland classification for map unit: Not prime farmland

Map Unit Composition

Absher and similar soils: 60 percent
Bearbou and similar soils: 25 percent
Dissimilar minor components: 15 percent

Description of the Absher Soil

Taxonomic Classification
Fine, smectitic, frigid Leptic Torrertic Natrustalfs

Setting
Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 0 to 3 percent
Parent material: Alluvium derived from shale and siltstone

Properties and Qualities
Depth to restrictive feature: 7 to 11 centimeters to natric horizon
Shrink-swell potential: High (about 7.7 LEP)
Salinity maximum based on representative value: Moderately saline (about 12.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 20.0
Calcium carbonate equivalent percent: 7

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Low
Natural drainage class: Moderately well drained
Flooding frequency: None
Ponding frequency: None
Depth to seasonal water table: About 95 to 115 centimeters (see table 18)
Available water capacity (entire profile): Very high (about 30.9 centimeters)

Typical Profile
A—0 to 9 centimeters; clay loam
Btkny—9 to 35 centimeters; clay
Btn—35 to 75 centimeters; clay
C1—75 to 105 centimeters; clay
C2—105 to 203 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated and irrigated areas): 7s
Ecological site name and ID: Saline Lowland, Drained (Foothills And Basins West) (R034AY240WY)
Hydric soil status: No
Hydrologic soil group: D

Description of the Bearbou Soil

Taxonomic Classification
Fine, smectitic, frigid Typic Endoaquolls

Setting
Landform: Flood plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Aspect (representative): North
Aspect range: All aspects
Slope range: 0 to 2 percent
Parent material: Alluvium derived from shale and siltstone

Properties and Qualities
Depth to restrictive feature: None within 150 centimeters
Shrink-swell potential: High (about 8.5 LEP)

Salinity maximum based on representative value: Very slightly saline (about 3.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio is about 5.0
Calcium carbonate equivalent percent: 10

Hydrologic Properties
Slowest capacity to transmit water (K_{sat}): Moderately low
Natural drainage class: Very poorly drained
Flooding frequency: Occasional (see table 18)
Ponding frequency: None
Depth to seasonal water table: About 8 to 14 centimeters (see table 18)
Available water capacity (entire profile): Very high (about 34.9 centimeters)

Typical Profile
A—0 to 11 centimeters; loam
Bw1—11 to 40 centimeters; loam
Bw2—40 to 70 centimeters; clay
BC—70 to 160 centimeters; clay
Cg—160 to 203 centimeters; clay

Interpretive Groups
Land capability subclass (nonirrigated and irrigated areas): 5w
Ecological site name and ID: Wetland (Foothills And Basins West) (R034AY278WY)
Hydric soil status: Yes
Hydrologic soil group: C/D

Minor Components

Dillon soils
Percent of map unit: 10 percent
Slope: 0 to 3 percent
Landform: Flood plains
Ecological site name and ID: Saline Subirrigated (Foothills And Basins West) (R034AY242WY)
Hydric soil status: No

Riverwash
Percent of map unit: 5 percent
Slope: 0 to 2 percent

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and forestland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreational facilities; and as wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Interpretive Ratings

The interpretive tables in this survey rate the soils in the survey area for various uses. Many of the tables identify the limitations that affect specified uses and indicate the severity of those limitations. The ratings in these tables are both verbal and numerical.

Rating Class Terms

Rating classes are expressed in the tables in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use or in terms that indicate the suitability of the soils for the use. Thus, the tables may show limitation classes or suitability classes. Terms for the limitation classes are *not limited, somewhat limited,* and *very limited*. The suitability ratings are expressed as *well suited, moderately suited, poorly suited,* and *unsuited* or as *good, fair,* and *poor*.

Numerical Ratings

Numerical ratings in the tables indicate the relative severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact

on the use and the point at which the soil feature is not a limitation. The limitations appear in order from the most limiting to the least limiting. Thus, if more than one limitation is identified, the most severe limitation is listed first and the least severe one is listed last.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forestland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit (USDA-SCS, 1961).

Capability classes, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class 1 soils have slight limitations that restrict their use.

Class 2 soils have moderate limitations that restrict the choice of plants or that require moderate conservation practices.

Class 3 soils have severe limitations that restrict the choice of plants or that require special conservation practices, or both.

Class 4 soils have very severe limitations that restrict the choice of plants or that require very careful management, or both.

Class 5 soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 6 soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 7 soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.

Class 8 soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, 2e. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class 1 there are no subclasses because the soils of this class have few limitations. Class 5 contains only the subclasses indicated by *w, s,* or *c* because the soils in class 5 are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, forestland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally

designated by adding an Arabic numeral to the subclass symbol, for example, 2e-4 and 3e-6. These units are not given in all soil surveys.

The capability classification of map units in this survey area is given in table 2 and in the section “Detailed Soil Map Units.”

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation’s short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation’s prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

There are no areas in Fossil Butte National Monument that meet the soil requirements for prime farmland.

Hydric Soils

Table 3 lists the map unit components that are rated as hydric soils in the park. This list can help in planning land uses; however, onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; USDA-NRCS, 2010).

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin and others, 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria

are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in “Soil Taxonomy” (Soil Survey Staff, 1999) and “Keys to Soil Taxonomy” (Soil Survey Staff, 2010) and in the “Soil Survey Manual” (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in “Field Indicators of Hydric Soils in the United States” (USDA-NRCS, 2010).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

The criteria for hydric soils are represented by codes in the table (for example, 2B3). Definitions for the codes are as follows:

1. All Histels except for Folistels and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
   A. are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
   B. are poorly drained or very poorly drained and have either:
      1) a water table at the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
      2) a water table at a depth of 0.5 foot or less during the growing season if saturated hydraulic conductivity (K_{sat}) is equal to or greater than 6.0 in/hr in all layers within a depth of 20 inches, or
      3) a water table at a depth of 1.0 foot or less during the growing season if saturated hydraulic conductivity (K_{sat}) is less than 6.0 in/hr in any layer within a depth of 20 inches.
3. Soils that are frequently ponded for periods of long or very long duration during the growing season.
4. Soils that are frequently flooded for periods of long or very long during the growing season.

Ecological Sites

Plant communities are largely dependent on the soil, climate, topography, aspect and slope of the landscape, as well as other abiotic features. To better understand these soil-plant interactions and the effects of selected management practices, the Natural Resources Conservation Service classifies forestlands and rangelands into ecological sites. Approved ecological site descriptions are available online at https://esis.sc.egov.usda.gov/.

Landscapes of native vegetation are divided into ecological sites for the purposes of inventory, evaluation, and management. An ecological site, as defined for rangeland,

is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation.

An ecological site is the product of all the environmental factors responsible for its development, including parent material, landscape, climate, soils, living organisms, hydrology, fire, and time in place. Ecological site descriptions contain information on each of these environmental factors. Included are brief descriptions of: a) physiographic and climatic features; b) major identifiable plant community types that may occupy the site, including the reference plant community; c) total annual production; d) ecological dynamics of the plant communities; e) soils and their main properties; f) and site interpretations and general management considerations for wildlife, hydrology, recreation, fire, aesthetics, and restoration/revegetation.

The reference plant community for a site is the plant community that has evolved under natural ecological processes and disturbances and is considered to be at its highest natural site potential under the current climate. It is a plant community that has developed on the site as a result of all site-forming factors and is best adapted to the unique combination of environmental factors associated with the site. Natural disturbances, such as fire, drought, herbivory, and flooding, were inherent in the development and maintenance of these reference plant communities. Plant communities that are or have been subjected to anthropogenic disturbances or physical site deterioration or have been protected from their natural disturbance regimes do not typify the reference state and may exist in a stable or steady state that is different from the reference plant community.

The reference plant community of an ecological site is not a precise assemblage of species for which the proportions are the same from place to place or from year to year. In all plant communities, variability is apparent in productivity and occurrence of individual species. Special boundaries of the communities can be recognized by characteristic patterns of species composition, association, and community structure. Generally one species or group of species dominates the site, and their stability within the natural dynamics or disturbances to the site allows them to be used as the distinguishing factor to differentiate one site from another.

At times, less frequently occurring plants may increase on a site or plants not formerly found in the reference community may invade the site. The presence or abundance of these plants may fluctuate greatly due to the plant's ability to adapt to the differences in the microenvironment, weather conditions, soil alterations, or human actions. Using these species for site identification can be misleading; thus, they should not be used to differentiate sites.

The following ecological site inventory methods are used in determining the characteristic plant communities of an ecological site:

1. Identification and evaluation of reference and/or relict sites with similar plant communities and associated soils.
2. Interpolation and extrapolation of plant, soil, and climatic data from existing historic reference areas along a continuum to other points on that continuum for which no suitable reference community is available.
3. Evaluation and comparison of the same ecological site occurring in different areas, where it has experienced different levels of disturbance and management. Further comparison is made with areas that are not disturbed.
4. Evaluating and interpretation of research data dealing with the ecology, management, and soils of plant communities.
5. Review of historical accounts, survey and military records, and botanical literature of the area.

The initial description of the reference state should be considered as an approximation subject to modification as additional knowledge is gained or discovered.

Plant communities change along environmental gradients. When changes in soils, aspect, topography, or moisture conditions are abrupt, the plant community

boundaries will be reasonably distinct. Boundaries are less distinct or visible where the plant communities change gradually over wide environmental gradients of relatively uniform soils and topography. Thus, the need for site differentiation may not be readily apparent until the cumulative impact of soil, topography, hydrology, or climate is examined over a broad area. Frequently, such differences are reflected first in production and second in the kinds and proportions of a plant species making up the core of the plant community. In some cases, the boundaries that are drawn between ecological sites along a continuum of closely related soils and a gradually changing climate are somewhat arbitrary.

The following criteria are used to differentiate one ecological site from another:

1. Significant differences in the species or species groups that are in the characteristic plant community.
2. Significant differences in the relative proportion of species or species groups in the characteristic plant community.
3. Significant differences in the total annual production/site index of the characteristic plant community.
4. Soil factors that determine the plant production and composition, the hydrology of the site, and the functioning of the ecological process of the water cycle, mineral cycles, and energy flow.

Differences in kind, proportion, and production of plants are the result of differences in soil, topography, and climate and other environmental factors. Slight variations in these factors are not criteria for site differentiation. Individual environmental factors are frequently associated with significant differences in reference plant communities. The differences in the environmental factors must be great enough to affect the kinds, amounts and proportions of the plant community to be differentiated into a distinct site.

Forestland is a spatially defined site where the reference community is dominated by a minimum 25 percent tree species overstory canopy cover, as determined by a crown perimeter-vertical projection. The reference community is the climax community that is present today that most resembles the forest conditions prior to European contact. It developed with natural disturbances such as drought, fire, and insects. Several other plant communities may be present during the seral stages of development. Vegetation on forestland provides many habitat components, assists in controlling soil erosion, is suitable for grazing or browsing by wildlife, and offers scenic and recreational opportunities. Forestland is environmentally and economically important. For more information about NRCS national forestry policies, see the NRCS "National Forestry Manual," which is available online at http://soils.usda.gov/technical/nfmanual/.

The reference community for a rangeland ecological site does not have the potential to produce a minimum 25 percent tree species overstory canopy cover. Several other plant communities may be present during phases of development or altered conditions. Vegetation on rangeland provides many habitat components, assists in controlling soil erosion, is suitable for grazing or browsing by wildlife and domestic animals, and offers scenic and recreational opportunities. Rangeland is environmentally and economically important.

Ecological Site Tables

Table 4—Climate, Landscape, Landform, Parent Material, and Ecosite ID. This table summarizes the climatic features by map unit symbol and soil name and percent of map unit with the correlated ecological site name and number. Climatic features include slope, elevation, MAP (mean annual precipitation), landscape, landform, and parent material.

Table 5—Ecological Site-Soil Correlation. This table lists the map unit symbol, component percent and soil name (component) with the ecological site name, ecological site type (Forestland or Rangeland), and ecological site ID (ecological site

number). Ecological site descriptions (available online at https://esis.sc.egov.usda.gov/) are dynamic documents that are constantly updated as new research and data is gained; thus, the online version, even after approval, will be the most recent version of the descriptions.

Land Management

In table 6, parts I through IV, interpretive ratings are given for various aspects of land management. The ratings are both verbal and numerical.

Some rating class terms indicate the degree to which the soils are suited to a specified land management practice. *Well suited* indicates that the soil has features that are favorable for the specified practice and has no limitations. Good performance can be expected, and little or no maintenance is needed. *Moderately suited* indicates that the soil has features that are moderately favorable for the specified practice. One or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. *Poorly suited* indicates that the soil has one or more properties that are unfavorable for the specified practice. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration. *Unsuited* indicates that the expected performance of the soil is unacceptable for the specified practice or that extreme measures are needed to overcome the undesirable soil properties.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified land management practice (1.00) and the point at which the soil feature is not a limitation (0.00).

Rating class terms for *fire damage* and *seedling mortality* are expressed as low, moderate, and high. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for fire damage or seedling mortality is highest (1.00) and the point at which the potential is lowest (0.00).

Rating class terms for *hazard of erosion* are expressed as slight, moderate, severe, and very severe. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for erosion is highest (1.00) and the point at which the potential is lowest (0.00).

The paragraphs that follow indicate the soil properties considered in rating the soils for land management practices.

Planting

Ratings in the columns *suitability for hand planting* and *suitability for mechanical planting* are based on slope, depth to a restrictive layer, content of sand, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, poorly suited, or unsuited to these methods of planting. It is assumed that necessary site preparation is completed before seedlings are planted.

Ratings in the column *suitability for use of harvesting equipment* indicate the suitability of the soils for harvesting with heavy equipment. It assumes the use of standard rubber-tired skidders and bulldozers for ground-based harvesting and transport. It considers the off-road transport or harvest of logs and/or wood products by ground-based wheeled or tracked equipment. Activities that disturb from 35 to 75 percent of the surface area with rutting, puddling, or displacement up to a depth of 18 inches are considered. Year-round water tables and year-round ponding are unfavorable. Ratings do not assess non-soil obstacles, such as slash, or frozen or snow-covered soils.

Hazard of Erosion and Suitability for Roads

Ratings in the column *hazard of erosion* are based on slope and on soil erodibility factor K. The soil loss is caused by sheet or rill erosion in areas where 50 to 75 percent of the surface has been exposed by different kinds of disturbance. The hazard is described as slight, moderate, severe, or very severe. A rating of *slight* indicates that erosion is unlikely under ordinary climatic conditions; *moderate* indicates that some erosion is likely and that erosion-control measures may be needed; *severe* indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and *very severe* indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Ratings in the column *hazard of erosion on roads and trails* are based on the soil erodibility factor K, slope, and content of rock fragments. The ratings apply to unsurfaced roads and trails. The hazard is described as slight, moderate, or severe. A rating of *slight* indicates that little or no erosion is likely; *moderate* indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and *severe* indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

Ratings in the column *suitability for roads (natural surface)* are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification, depth to a water table, ponding, flooding, and the hazard of soil slippage. The ratings indicate the suitability for using the natural surface of the soil for roads. The soils are described as well suited, moderately suited, or poorly suited to this use.

Site Preparation

Ratings in the column *suitability for mechanical site preparation (deep)* are based on slope, depth to a restrictive layer, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 3 feet is considered in the ratings.

Ratings in the column *suitability for mechanical site preparation (surface)* are based on slope, depth to a restrictive layer, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 1 foot is considered in the ratings.

Site Restoration

Ratings in the column *potential for damage to soil by fire* are based on texture of the surface layer, content of rock fragments and organic matter in the surface layer, thickness of the surface layer, and slope. The soils are described as having a low, moderate, or high potential for this kind of damage. The ratings indicate an evaluation of the potential impact of prescribed fires or wildfires that are intense enough to remove the duff layer and consume organic matter in the surface layer.

Ratings in the column *potential for seedling mortality* are based on flooding, ponding, depth to a water table, content of lime, reaction, salinity, available water capacity, soil moisture regime, soil temperature regime, aspect, and slope. The soils are described as having a low, moderate, or high potential for seedling mortality.

Recreation

The soils of the park are rated in table 7, parts I and II, according to limitations that affect their suitability for recreation. The ratings are both verbal and numerical. Rating

class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings in the table are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for building site development, construction materials, and water management.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas. The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Foot traffic and equestrian trails for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil

properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Mountain bike and off-road vehicle trails require little or no site preparation. They are not covered with surfacing material or vegetation. Considerable compaction of the soil material is likely. The ratings are based on the soil properties that influence erodibility, trafficability, dustiness, and the ease of revegetation. These properties are stoniness, depth to a water table, ponding, slope, flooding, and texture of the surface layer.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the data in the tables described under the heading “Soil Properties.”

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about particle-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 7 feet of the surface, soil wetness, depth to a water table, ponding, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Dwellings and Small Commercial Buildings

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Table 8 shows the degree and kind of soil limitations that affect dwellings and small commercial buildings.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet. The ratings for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Compressibility is inferred from the Unified classification. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification). The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Roads and Streets, Shallow Excavations, and Landscaping

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Table 9 shows the degree and kind of soil limitations that affect local roads and streets, shallow excavations, and landscaping.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

Landscaping requires soils on which turf, trees, and shrubs can be established and maintained. Irrigation is not considered in the ratings. The ratings are based on the soil properties that affect plant growth and trafficability after vegetation is established. The properties that affect plant growth are reaction; depth to a water table; ponding; depth to bedrock or a cemented pan; the available water capacity in the upper 40 inches; the content of salts, sodium, or calcium carbonate; and sulfidic materials. The properties that affect trafficability are flooding, depth to a water table, ponding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer.

Sewage Disposal

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields and sewage lagoons. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that

are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. Saturated hydraulic conductivity (K_{sat}), depth to a water table, ponding, depth to bedrock or a cemented pan, and flooding affect absorption of the effluent. Stones and boulders, ice, and bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the ground water may become contaminated.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Considered in the ratings are slope, saturated hydraulic conductivity (K_{sat}), depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, large stones, and content of organic matter.

Saturated hydraulic conductivity (K_{sat}) is a critical property affecting the suitability for sewage lagoons. Most porous soils eventually become sealed when they are used as sites for sewage lagoons. Until sealing occurs, however, the hazard of pollution is severe. Soils that have a K_{sat} rate of more than 14 micrometers per second are too porous for the proper functioning of sewage lagoons. In these soils, seepage of the effluent can result in contamination of the ground water. Ground-water contamination is also a hazard if fractured bedrock is within a depth of 40 inches, if the water table is high enough to raise the level of sewage in the lagoon, or if floodwater overtops the lagoon.

A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor. If the lagoon is to be uniformly deep throughout, the slope must be gentle enough and the soil material must be thick enough over bedrock or a cemented pan to make land smoothing practical.

Source of Gravel and Sand

Table 11 gives information about the soils as potential sources of gravel and sand. Normal compaction, minor processing, and other standard construction practices are assumed.

Gravel and *sand* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. Only the likelihood of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material. The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the Unified

classification of the soil), the thickness of suitable material, and the content of rock fragments. If the bottom layer of the soil contains sand or gravel, the soil is considered a likely source regardless of thickness. The assumption is that the sand or gravel layer below the depth of observation exceeds the minimum thickness. The ratings are for the whole soil, from the surface to a depth of about 6 feet.

The soils are rated *good, fair,* or *poor* as potential sources of sand and gravel. A rating of *good* or *fair* means that the source material is likely to be in or below the soil. The bottom layer and the thickest layer of the soils are assigned numerical ratings. These ratings indicate the likelihood that the layer is a source of sand or gravel. The number 0.00 indicates that the layer is a poor source. The number 1.00 indicates that the layer is a good source. A number between 0.00 and 1.00 indicates the degree to which the layer is a likely source.

Source of Reclamation Material, Roadfill, and Topsoil

Table 12 gives information about the soils as potential sources of reclamation material, roadfill, and topsoil. Normal compaction, minor processing, and other standard construction practices are assumed.

The soils are rated *good, fair,* or *poor* as potential sources of reclamation material, roadfill, and topsoil. The features that limit the soils as sources of these materials are specified in the table. Numerical ratings between 0.00 and 0.99 are given after the specified features. These numbers indicate the degree to which the features limit the soils as sources of topsoil, reclamation material, or roadfill. The lower the number, the greater the limitation.

Reclamation material is used in areas that have been drastically disturbed by surface mining or similar activities. When these areas are reclaimed, layers of soil material or unconsolidated geological material, or both, are replaced in a vertical sequence. The reconstructed soil favors plant growth. The ratings in the table do not apply to quarries and other mined areas that require an offsite source of reconstruction material. The ratings are based on the soil properties that affect erosion and stability of the surface and the productive potential of the reconstructed soil. These properties include the content of sodium, salts, and calcium carbonate; reaction; available water capacity; erodibility; texture; content of rock fragments; and content of organic matter and other features that affect fertility.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments. The ratings are for the whole soil, from the surface to a depth of about 5 feet. It is assumed that soil layers will be mixed when the soil material is excavated and spread.

The ratings are based on the amount of suitable material and on soil properties that affect the ease of excavation and the performance of the material after it is in place. The thickness of the suitable material is a major consideration. The ease of excavation is affected by large stones, depth to a water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the AASHTO classification of the soil) and linear extensibility (shrink-swell potential).

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area. The ratings are based on the soil properties that affect plant growth; the ease of excavating, loading, and spreading the material; and reclamation of the borrow area. Toxic substances, soil reaction, and the properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. The ease of excavating, loading, and spreading is affected by rock fragments, slope, depth to a water table, soil texture, and thickness of suitable

material. Reclamation of the borrow area is affected by slope, depth to a water table, rock fragments, depth to bedrock or a cemented pan, and toxic material.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey.

Soil properties are ascertained by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine particle-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties are shown in tables. They include engineering properties, physical and chemical properties, and pertinent soil and water features.

Engineering Properties

Table 13 gives the engineering classifications and the range of engineering properties for the layers of each soil in the park.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. “Loam,” for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, “gravelly.”

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement,

the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 250 millimeters in diameter and 70 to 250 millimeters in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical Soil Properties

Table 14 shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the park. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (K_{sat}), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at $^1/_3$- or $^1/_{10}$-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water

and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability (K_{sat}) refers to the ability of a soil to transmit water or air. The term "permeability," as used in soil surveys, indicates saturated hydraulic conductivity (K_{sat}). The estimates in the table indicate the rate of water movement, in inches per hour, when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on the basis of measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; *high,* 6 to 9 percent; and *very high,* greater than 9 percent.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion Properties

Table 15 shows estimates of some erosion factors that affect a soil's potential for different uses. These estimates are given for each layer of every soil for K factors and are given as one rating for the entire soil for the T factor, the wind erodibility group, and the wind erodibility index. Values are reported for each soil in the park. Estimates are based on field observations and on test data for these and similar soils.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Soil erosion factors Kw and Kf quantify soil detachment by runoff and raindrop impact. These erosion factors are indexes used to predict the long-term average soil loss from sheet and rill erosion under crop systems and conservation techniques. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and K_{sat}. Values

of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

The procedure for determining the Kf factor is outlined in Agriculture Handbook 703, "Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE)," USDA, Agricultural Research Service, 1997.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments. In horizons where total rock fragments are 15 percent or more, by volume, the Kw factor is always less than the Kf factor.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size. Soil horizons that do not have rock fragments are assigned equal Kw and Kf factors.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the "National Soil Survey Handbook."

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Total Soil Carbon

Table 16 gives estimates of total soil carbon. Soil carbon occurs as organic and inorganic carbon.

Soil organic carbon (SOC) is carbon (C) in soil that originated from a biological source, such as plants, animals, or micro-organisms. SOC is found in both organic and mineral soil layers. The term "soil organic carbon" refers only to the carbon occurring in soil organic matter (SOM). Soil organic carbon makes up about one-half the weight of soil organic matter. The rest of SOM is mostly oxygen, nitrogen, and hydrogen.

Soil inorganic carbon (SIC) is carbon found in soil carbonates, typically as calcium carbonate layers in the soil or as clay-sized fractions throughout the soil. Carbonates in soils are most common in areas where evaporation rates exceed precipitation, as is the case in most desert environments. Typically, the carbonates accumulated from carbonatic dust or from solution during periods of wetter climates. Soil inorganic carbon also occurs in soils that formed in marl in all regions of the country.

The SOC and SIC contents are reported in kilograms per square meter to a depth of 2 meters or to a representative depth of either hard bedrock or a cemented horizon. The SOC and SIC values are on a whole soil basis, corrected for rock fragments.

SOC can be an indicator of overall soil fertility and soil quality that affects ecosystem function. SOM is the main reservoir for most plant nutrients, such as phosphorus and nitrogen. Managing for SOC by managing for SOM increases the content of these elements and improves soil resiliency.

Soil organic matter binds soil particles together and thus increases soil porosity and water infiltration and allows better root penetration and waterflow into the soil. Greater inflow of water reduces the hazard of erosion and the rate of surface water runoff.

Greater SOC levels improve not only soil quality but also the quality of air and water. Soil acts as a filter and improves water quality. Fertile soils that support plant life remove CO_2 from the atmosphere and increase oxygen levels through photosynthesis. Maintaining the level of soil organic carbon reduces C release into the atmosphere and thus can lessen the effects of global warming.

SIC influences the types of plants that will grow. High SIC levels are commonly associated with a higher soil pH, which limits the types of plants that will thrive.

Like SOM, soil carbonates, the source of SIC, also bind soil particles together. They fill voids in the soil and thus can reduce soil porosity. Compacted soil carbonates may restrict root penetration and waterflow into the soil.

Soil Features

Table 17 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness and thickness of the restrictive layer, both of which significantly affect the ease of excavation. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (K_{sat}), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Water Features

Table 18 gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. Table 18 indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Chemical Soil Properties

Table 19 shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the park. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Effective cation-exchange capacity refers to the sum of exchangeable cations plus aluminum expressed in terms of milliequivalents per 100 grams of soil. It is determined for soils that have pH of less than 5.5.

Soil reaction is a measure of acidity or alkalinity. The pH of each soil horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity (K_{sat}) and aeration, and a general degradation of soil structure.

Classification of the Soils

Soils are named and classified on the basis of physical and chemical properties in their horizons (layers). Color, texture, structure, and other properties of the soil to a depth of 2 meters are used to key the soil into a classification system. This system helps people to use soil information and also provides a common language for scientists.

Soils and their horizons differ from one another, depending on how and when they formed. Soil scientists use the five soil-forming factors to help predict where different soils may occur. The degree and expression of the soil horizons reflect the extent of interaction of the soil-forming factors with one or more of the soil-forming processes (Simonson, 1959).

When mapping soils, a soil scientist looks for areas with similar soil-forming factors to find similar soils. The properties of the soils are described. Soils with the same kind of properties are given taxonomic names. Soils are classified, mapped, and interpreted on the basis of various kinds of soil horizons and their arrangement. The distribution of soil orders corresponds with the general patterns of the soil-forming factors within the park.

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1999 and 2010). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. The categories are defined in the following paragraphs.

ORDER. Soil taxonomy at the highest hierarchical level identifies 12 soil orders. The names for the orders and taxonomic soil properties relate to Greek, Latin, or other root words that reveal something about the soil. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Alfisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. Sixty-four suborders are recognized at the next level of classification. The last syllable in the name of a suborder indicates the order. An example is Cryalf (*Cry*, meaning cold, plus *alf,* from Alfisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. There are about 300 great groups. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplocryalf (*Hapl,* meaning simple or minimal horizon development, plus *cryalf,* the suborder of the Alfisols that has a cryic temperature regime.)

SUBGROUP. There are more than 2,400 subgroups. Each great group has a typic subgroup. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Other subgroups are intergrades or extragrades. Intergrades are transitions to other orders, suborders, or great groups. Extragrades

have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Vertic* identifies the subgroup that has high shrink-swell clays. An example is Vertic Haplocryalfs.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties for family placement are those of horizons below a traditional agronomic plow depth. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, smectitic Vertic Haplocryalfs.

SERIES. The soil series is the lowest category in the soil classification system. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. An example is the Fossilbutte series, which is classified as fine, smectitic Vertic Haplocryalfs.

Most parks are mapped to the series level. The names of soil series are selected by the soil scientists during the course of mapping. The series names are commonly geographic place names, such as Cundick and Fossilbutte, or are coined. Because of access limitations and soil variability, soils in some remote areas are classified at the great group or subgroup level.

Table 20 indicates the order, suborder, great group, subgroup, and family of the soil series in the park. Table 21 displays the classification as a key sorted by order.

Seven new series were established in the park during the course of mapping: Cundick, Ducktail, Fossilbutte, Gunsone, Quakenasp, Swiftcreek, and Ulric. Descriptions of these follow.

Cundick Series

Landform: Mesas, ridges, and buttes
Elevation: 2,280 to 2,450 meters
Slope: 1 to 20 percent
Parent material: Slope alluvium or colluvium derived from limestone
Mean annual precipitation: 380 to 480 millimeters
Mean annual air temperature: 2.5 to 5.0 degrees C
Frost-free period: 30 to 60 days
Drainage class: Well drained
Depth class: Moderately deep

Taxonomic Classification

Fine-loamy, mixed, superactive Ustic Haplocryalfs

Typical Pedon

Cundick gravelly loam, in rangeland; Lincoln County, Wyoming; lat. 41 degrees 52 minutes 42.80 seconds N. and long. 110 degrees 46 minutes 24.80 seconds W.; NAD83, UTM 518789e, 4636315n, zone 12. (Colors are for dry soil unless otherwise stated.)

A—0 to 15 centimeters; pale brown (10YR 6/3) gravelly loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; few fine and common very fine irregular pores; 15 percent subangular limestone gravel; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (10 to 20 centimeters thick)

Btk—15 to 42 centimeters; brown (10YR 5/3) gravelly loam, brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine and few fine dendritic tubular pores; 20 percent faint clay films on vertical faces of peds; 20 percent subangular limestone gravel; 1 percent fine faint irregular carbonate masses in the matrix and finely disseminated calcium carbonate; violently effervescent; strongly alkaline (pH 8.5); clear smooth boundary. (20 to 40 centimeters thick)

Bk—42 to 68 centimeters; pale brown (10YR 6/3) gravelly loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, moderately sticky and slightly plastic; common very fine and few fine roots; few very fine and fine dendritic tubular pores; 25 percent subangular limestone gravel and 5 percent limestone flagstones; 3 percent fine faint irregular carbonate masses in the matrix and finely disseminated calcium carbonate; violently effervescent; strongly alkaline (pH 8.5); gradual smooth boundary. (15 to 45 centimeters thick)

BCk—68 to 84 centimeters; very pale brown (10YR 7/3) very gravelly loam, brown (10YR 5/3) moist; weak coarse subangular blocky structure; slightly hard, friable, moderately sticky and slightly plastic; few very fine roots; few very fine dendritic tubular pores; 25 percent subangular limestone gravel and 10 percent subangular limestone flagstones; 2 percent fine faint irregular carbonate masses in the matrix and finely disseminated calcium carbonate; violently effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary. (0 to 25 centimeters thick)

R—84 centimeters; strongly cemented limestone.

Range in Characteristics

Mean annual soil temperature: 2.0 to 4.5 degrees C
Depth to an argillic horizon: 10 to 20 centimeters
Thickness of argillic horizon: 20 to 40 centimeters
Depth to secondary calcium carbonate accumulation: 10 to 20 centimeters
Depth to a calcic horizon: 30 to 60 centimeters
Depth to a lithic contact: 50 to 100 centimeters

A horizon:
- Hue—7.5YR or 10YR, dry or moist
- Value—4 to 6 dry; 3 or 4 moist
- Chroma—2 or 3, dry or moist
- Clay content—16 to 20 percent
- Rock fragments—15 to 30 percent gravel
- Calcium carbonate equivalent—3 to 10 percent
- Reaction—pH 7.9 to 8.4

Btk horizon:
- Hue—7.5YR or 10YR, dry or moist
- Value—4 to 6 dry; 3 to 5 moist
- Chroma—3 or 4, dry or moist
- Texture—loam or clay loam
- Clay content—20 to 35 percent
- Rock fragments—15 to 35 percent gravel
- Calcium carbonate equivalent—5 to 15 percent
- Sodium adsorption ratio—0 to 8 percent
- Reaction—pH 8.0 to 8.8

Bk and BCk horizons:
- Hue—7.5YR or 10YR, dry or moist
- Value—5 to 7 dry; 4 to 6 moist
- Chroma—2 or 3, dry or moist

Clay content—18 to 27 percent
Rock fragments—20 to 40 percent (20 to 35 percent gravel and 0 to 15 percent limestone flagstones)
Calcium carbonate equivalent—15 to 25 percent
Sodium adsorption ratio—0 to 8 percent
Reaction—pH 8.0 to 8.8

Ducktail Series

Landform: Escarpments
Elevation: 2,195 to 2,377 meters
Slope: 60 to 80 percent
Parent material: Colluvium derived from limestone
Mean annual precipitation: 450 to 610 millimeters
Mean annual air temperature: 2.2 to 4.4 degrees C
Frost-free period: 20 to 40 days
Drainage class: Well drained
Depth class: Very deep

Taxonomic Classification

Coarse-loamy, mixed, superactive Typic Haplocryolls

Typical Pedon

Ducktail loam, in forestland; Lincoln County, Wyoming; lat. 41 degrees 52 minutes 47.10 seconds N. and long. 110 degrees 45 minutes 48.66 seconds W.; NAD83, UTM 519623 meters E, 4636454 meters N, zone 12. (Colors are for dry soil unless otherwise noted.)

Oi—0 to 5 centimeters; slightly decomposed forest litter.
A1—5 to 15 centimeters; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common fine and very fine dendritic tubular pores and common fine interstitial pores; 10 percent angular limestone gravel; finely disseminated calcium carbonate; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (8 to 18 centimeters thick)
A2—15 to 41 centimeters; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common fine and few medium and coarse dendritic tubular pores and common fine interstitial pores; 15 percent angular limestone gravel; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.4); gradual smooth boundary. (15 to 30 centimeters thick)
C—41 to 200 centimeters; light yellowish brown (2.5Y 6/3) gravelly sandy loam, olive brown (2.5Y 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; few fine dendritic tubular pores and common interstitial pores; 15 percent angular limestone gravel and 5 percent angular limestone cobbles; finely disseminated calcium carbonate; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Mean annual soil temperature: 3.3 to 5.6 degrees C
Thickness of mollic epipedon: 25 to 40 centimeters

A1 horizon:
Hue—10YR or 2.5Y, dry or moist

Value—4 or 5 dry; 2 or 3 moist
Chroma—2 to 3, dry or moist
Clay content—10 to 16 percent
Rock fragments—10 to 25 percent limestone gravel
Calcium carbonate equivalent—5 to 15 percent
Reaction—pH 7.8 to 8.4

A2 horizon:
Hue—10YR or 2.5Y, dry or moist
Value—4 or 5 dry; 2 or 3 moist
Chroma—2 or 3, dry or moist
Clay content—10 to 16 percent
Rock fragments—10 to 25 percent gravel
Calcium carbonate equivalent—10 to 20 percent
Reaction—pH 7.8 to 8.4

C horizon:
Hue—10YR or 2.5Y, dry or moist
Value—6 or 7 dry; 4 to 6 moist
Chroma—3 or 4, dry or moist
Clay content—11 to 18 percent
Rock fragments—5 to 25 percent (5 to 20 percent limestone gravel and 0 to 5 percent limestone cobbles)
Calcium carbonate equivalent—15 to 35 percent
Reaction—pH 7.8 to 8.4

Fossilbutte Series

Landform: Ridges, mesas, and buttes
Elevation: 2,250 to 2,450 meters
Slope: 1 to 20 percent
Parent material: Slope alluvium derived from interbedded sandstone and shale
Mean annual precipitation: 380 to 480 millimeters with peak periods of precipitation occurring from March to June
Mean annual air temperature: 3.0 to 5.0 degrees C
Frost-free period: 30 to 60 days
Drainage class: Well drained
Depth class: Very deep

Taxonomic Classification

Fine, smectitic Vertic Haplocryalfs

Typical Pedon

Fossilbutte clay loam, in rangeland; Lincoln County, Wyoming; lat. 41 degrees 53 minutes 47.65 seconds N. and long. 110 degrees 46 minutes 18.84 seconds W.; NAD83, UTM 518921 meters E, 4638318 meters N, zone 12. (Colors are for dry soil unless otherwise noted.)

A—0 to 7 centimeters; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots throughout; common very fine and fine dendritic tubular pores; very slightly effervescent; slightly alkaline (pH 7.6); clear smooth boundary. (5 to 15 centimeters thick)
Bt1—7 to 15 centimeters; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable,

moderately sticky and moderately plastic; common very fine and fine and few medium roots throughout; common very fine and fine dendritic tubular pores; 10 percent faint clay films on all faces of peds; finely disseminated calcium carbonate; slightly effervescent; slightly alkaline (pH 7.4); clear smooth boundary. (0 to 15 centimeters thick)

Bt2—15 to 79 centimeters; brown (7.5YR 5/3) clay, brown (7.5YR 4/3) moist; strong medium prismatic structure parting to strong medium angular; hard, firm, moderately sticky and very plastic; few fine roots throughout and few medium roots between peds; few very fine dendritic tubular pores; 70 percent distinct clay films on all faces of peds; 5 percent angular sedimentary gravel; finely disseminated calcium carbonate; slightly effervescent; slightly alkaline (pH 7.4); gradual smooth boundary. (45 to 85 centimeters thick)

Btk1—79 to 99 centimeters; reddish brown (5YR 5/3) clay, reddish brown (5YR 4/3) moist; moderate medium angular blocky structure; hard, firm, moderately sticky and very plastic; few very fine roots throughout; few very fine dendritic tubular pores; 45 percent distinct clay films on all faces of peds; 10 percent angular sedimentary gravel; 1 percent faint irregular carbonate masses on faces of peds and finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0); gradual smooth boundary. (8 to 30 centimeters thick)

Btk2—99 to 200 centimeters; reddish brown (5YR 5/3) clay, reddish brown (5YR 4/3) moist; moderate medium angular blocky structure; hard, firm, moderately sticky and very plastic; few very fine dendritic tubular pores; 20 percent faint clay films on vertical faces of peds; 5 percent angular sedimentary gravel; 7 percent prominent medium irregular carbonates masses in the matrix and finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0).

Range in Characteristics

Mean annual soil temperature: 3.5 to 6.0 degrees C
Depth to top of argillic horizon: 10 to 25 centimeters
Depth to secondary calcium carbonate accumulation: 65 to 100 centimeters
Note: The Bt1 layer is not part of the argillic horizon

A horizon:
Hue—5YR to 10YR, dry or moist
Value—4 to 6 dry; 3 or 4 moist
Chroma—2 or 3, dry or moist
Clay content—27 to 35 percent
Rock fragments—0 to 5 percent gravel
Reaction—pH 7.0 to 7.6

Bt1 horizon:
Hue—5YR to 10YR, dry or moist
Value—4 to 6 dry; 3 or 4 moist
Chroma—2 or 3, dry or moist
Clay content—30 to 36 percent
Rock fragments—0 to 5 percent gravel
Calcium carbonate equivalent—0 to 3 percent
Reaction—pH 7.2 to 7.8

Bt2 horizon:
Hue—5YR to 10YR, dry or moist
Value—5 or 6 dry; 4 or 5 moist
Chroma—2 to 4, dry or moist
Texture—clay or clay loam
Clay content—35 to 50 percent
Rock fragments—0 to 20 percent gravel

Calcium carbonate equivalent—0 to 3 percent
Reaction—pH 7.2 to 7.8

Btk1 and Btk2 horizons:
Hue—5YR to 10YR, dry or moist
Value—5 or 6 dry; 4 or 5 moist
Chroma—2 to 4, dry or moist
Texture—clay or clay loam
Clay content—35 to 50 percent
Rock fragments—0 to 25 percent gravel
Calcium carbonate equivalent—5 to 15 percent
Reaction—pH 7.9 to 8.4

Gunsone Series

Landform: Hills
Elevation: 2,000 to 2,200 meters
Slope: 3 to 35 percent
Parent material: Slope alluvium over residuum derived from interbedded sandstone and shale
Mean annual precipitation: 275 to 380 millimeters with peak periods of precipitation occurring from March to June
Mean annual air temperature: 4.4 to 6.7 degrees C
Frost-free period: 60 to 90 days
Drainage class: Well drained
Depth class: Very deep

Taxonomic Classification

Fine, smectitic, frigid Torrertic Haplustalfs

Typical Pedon

Gunsone loam, in rangeland; Lincoln County, Wyoming; lat. 41 degrees 50 minutes 20.88 seconds N. and long. 110 degrees 46 minutes 42.66 seconds W.; NAD83, UTM 518389 meters E, 4631939 meters N, zone 12. (Colors are for dry soil unless otherwise noted.)

A—0 to 12 centimeters; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, friable, slightly sticky and nonplastic; common very fine and few fine roots throughout; few very fine and fine dendritic tubular pores and common interstitial pores; neutral (pH 7.2); clear smooth boundary. (8 to 15 centimeters thick)

Btk1—12 to 32 centimeters; dark yellowish brown (10YR 4/4) clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong medium angular blocky; moderately hard, firm, moderately sticky and moderately plastic; few very fine and fine roots throughout; common fine and very fine dendritic tubular pores; 40 percent faint clay films on all faces of peds; finely disseminated calcium carbonate; very slightly effervescent; slightly alkaline (pH 7.4); clear smooth boundary. (10 to 27 centimeters thick)

Btk2—32 to 84 centimeters; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; moderate medium prismatic structure parting to strong medium angular blocky; moderately hard, very firm, moderately sticky and very plastic; common very fine roots between peds; few fine and common very fine dendritic tubular pores; 60 percent distinct clay films on all faces of peds; finely disseminated calcium carbonate and 4 percent medium distinct irregular carbonate masses on all

faces of peds; slightly effervescent; moderately alkaline (pH 8.4); gradual smooth boundary. (30 to 60 centimeters thick)

BCkyz—84 to 115 centimeters; light yellowish brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) moist; weak medium subangular blocky structure; moderately hard, firm, moderately sticky and moderately plastic; few very fine roots; few very fine irregular pores; finely disseminated calcium carbonate and 1 percent fine faint irregular carbonate masses in the matrix; 3 percent fine distinct gypsum threads in the matrix; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary. (10 to 35 centimeters thick)

C—115 to 200 centimeters; light yellowish brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) moist; 10 percent fine reddish yellow (7.5YR 6/8) mottles and 5 percent fine reddish brown (2.5YR 5/3) mottles in the matrix; massive; moderately hard, firm, moderately sticky and moderately plastic; few very fine roots; few very fine irregular pores; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Mean annual soil temperature: 5.6 to 7.8 degrees C
Depth to top of argillic horizon: 8 to 15 centimeters
Depth to secondary calcium carbonate accumulation: 25 to 35 centimeters
Note: Some pedons have a 2BCk horizon

A horizon:
Hue—7.5YR or 10YR, dry or moist
Value—4 to 6 dry; 3 or 4 moist
Chroma—2 to 3, dry or moist
Clay content—18 to 27 percent
Rock fragments—0 to 2 percent gravel
Reaction—pH 7.0 to 7.5

Btk1 horizon:
Hue—7.5YR or 10YR, dry or moist
Value—4 or 5 dry; 3 or 4 moist
Chroma—3 or 4, dry or moist
Clay content—27 to 35 percent
Rock fragments—0 to 5 percent gravel
Calcium carbonate equivalent—1 to 3 percent
Reaction—pH 7.2 to 7.8

Btk2 horizon:
Hue—7.5YR or 10YR, dry or moist
Value—4 to 6, dry or moist
Chroma—2 to 4, dry or moist
Texture—clay or clay loam
Clay content—35 to 45 percent
Parafragments—0 to 10 percent weakly cemented shale paragravel
Calcium carbonate equivalent—2 to 5 percent
Electrical conductivity—1 to 4 mmhos/cm
Sodium adsorption ratio—0 to 5
Reaction—pH 8.0 to 8.6

BCkyz horizon:
Hue—7.5YR to 2.5Y, dry or moist
Value—4 to 6, dry or moist
Chroma—2 to 4, dry or moist

Texture—clay or clay loam
Clay content—35 to 45 percent
Parafragments—2 to 10 percent weakly cemented shale paragravel
Calcium carbonate equivalent—5 to 15 percent
Gypsum—1 to 3 percent
Electrical conductivity—8 to 16 mmhos/cm
Sodium adsorption ratio—3 to 12
Reaction—pH 8.0 to 8.6

C horizon:
Hue—7.5YR to 2.5Y, dry or moist
Value—5 or 6 dry; 4 or 5 moist
Chroma—3 or 4, dry or moist
Clay content—27 to 40 percent
Parafragments—0 to 30 percent weakly cemented shale paragravel
Calcium carbonate equivalent—10 to 20 percent
Gypsum—0 to 1 percent
Electrical conductivity—8 to 16 mmhos/cm
Sodium adsorption ratio—3 to 12
Reaction—pH 8.0 to 8.6

Quakenasp Series

Landform: Hills
Elevation: 2,200 to 2,400 meters
Slope: 20 to 35 percent
Parent material: Colluvium derived from limestone or interbedded shale and sandstone
Mean annual precipitation: 450 to 600 millimeters with peak periods of precipitation occurring from March to June
Mean annual air temperature: 2.0 to 4.5 degrees C
Frost-free period: 20 to 40 days
Drainage class: Well drained
Depth class: Very deep

Taxonomic Classification

Fine, smectitic Vertic Argicryolls

Typical Pedon

Quakenasp loam, in woodland; Lincoln County, Wyoming; lat. 41 degrees 53 minutes 24.90 seconds N. and long. 110 degrees 48 minutes 1.10 seconds W. (Colors are for dry soil unless otherwise noted.)

Oe—0 to 8 centimeters; moderately decomposed aspen leaves and twigs. (5 to 10 centimeters thick)
A—8 to 34 centimeters; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; many fine and common medium and coarse roots; common very fine and fine irregular pores; 8 percent subangular limestone gravel; neutral (pH 7.0); clear smooth boundary. (20 to 35 centimeters thick)
Btk1—34 to 47 centimeters; reddish brown (5YR 4/4) clay loam, reddish brown (5YR 4/3) moist; 15 percent reddish brown (2.5YR 5/4) and 5 percent grayish brown (2.5Y 5/2) mottles in the matrix; moderate medium prismatic structure parting to moderate medium subangular blocky; moderately hard, firm, moderately sticky and

moderately plastic; common fine, medium, and coarse roots; common very fine and few fine and medium dendritic tubular pores; 15 percent prominent clay films on all faces of peds; 10 percent subangular limestone gravel; finely disseminated calcium carbonate; slightly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Btk2—47 to 82 centimeters; reddish brown (2.5YR 5/3) clay, reddish brown (2.5YR 4/3) moist; 5 percent light olive brown (2.5Y 5/3) mottles in the matrix; moderate medium subangular blocky structure; moderately hard, firm, moderately sticky and very plastic; common very fine and fine and few medium roots; few very fine, fine, and medium dendritic tubular pores; 20 percent faint clay films on all faces of peds; 4 percent medium distinct irregular carbonate masses in the matrix and finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (Combined thickness of Btk1 and Btk2 horizons is 30 to 70 centimeters.)

C—82 to 200 centimeters; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; 10 percent light olive brown (2.5Y 5/3) mottles in the matrix; massive; moderately hard, very firm, moderately sticky and very plastic; few very fine and fine roots; few very fine and fine dendritic tubular pores; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Mean annual soil temperature: 3.0 to 5.5 degrees C
Thickness of mollic epipedon: 20 to 35 centimeters
Depth to argillic horizon: 25 to 40 centimeters
Thickness of argillic horizon: 30 to 70 centimeters
Depth to secondary calcium carbonate accumulation: 25 to 40 centimeters

A horizon:
- Hue—5YR to 10YR, dry or moist
- Value—2 to 4 dry; 2 or 3 moist
- Chroma—2 to 3, dry or moist
- Clay content—18 to 26 percent
- Rock fragments—0 to 15 percent gravel
- Reaction—pH 6.6 to 7.2

Btk1 and Btk2 horizons:
- Hue—2.5YR to 7.5YR, dry or moist
- Value—4 or 5 dry; 3 or 4 moist
- Chroma—3 or 4, dry or moist
- Texture—clay loam or clay
- Clay content—35 to 50 percent
- Rock fragments—0 to 15 percent gravel
- Calcium carbonate equivalent—5 to 15 percent
- Reaction—pH 8.0 to 8.6

C horizon:
- Hue—2.5YR to 7.5YR, dry or moist
- Value—4 to 6 dry; 3 to 5 moist
- Chroma—3 or 4, dry or moist
- Texture—clay loam or clay
- Clay content—35 to 45 percent
- Calcium carbonate equivalent—5 to 15 percent
- Reaction—pH 8.0 to 8.6

Swiftcreek Series

Landform: Hills and rotational slides
Elevation: 2,070 to 2,380 meters
Slope: 10 to 50 percent
Parent material: Colluvium, slope alluvium, or slide deposits derived from limestone
Mean annual precipitation: 450 to 610 millimeters
Mean annual air temperature: 4.4 to 6.7 degrees C
Frost-free period: 60 to 90 days
Drainage class: Well drained
Depth class: Very deep

Taxonomic Classification

Fine-loamy, mixed, superactive, frigid Typic Haplustepts

Typical Pedon

Swiftcreek gravelly loam, in rangeland; Lincoln County, Wyoming; lat. 41 degrees 52 minutes 24.80 seconds N. and long. 110 degrees 46 minutes 45.50 seconds W.; NAD83, UTM 518314 meters E, 4635757 meters N, zone 12. (Colors are for dry soil unless otherwise noted.)

A—0 to 9 centimeters; grayish brown (10YR 5/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine, common fine, and few medium roots; few fine and common very fine pores; 15 percent subangular limestone gravel; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0); gradual smooth boundary. (5 to 15 centimeters thick)

Bw1—9 to 30 centimeters; brown (10YR 5/3) gravelly loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few fine and common very fine dendritic tubular pores; 15 percent subangular limestone gravel; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

Bw2—30 to 68 centimeters; pale brown (10YR 6/3) gravelly sandy clay loam, brown (10YR 4/3) moist; moderate coarse subangular blocky structure; soft, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few fine and very fine dendritic tubular pores; 20 percent subangular limestone gravel and 5 percent limestone flagstones; finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary. (Combined thickness of Bw1 and Bw2 horizons is 40 to 70 centimeters.)

C—68 to 200 centimeters; very pale brown (10YR 7/3) very gravelly sandy clay loam, brown (10YR 5/3) moist; massive; soft, friable, moderately sticky and slightly plastic; few very fine roots; few very fine dendritic tubular pores; 25 percent subangular limestone gravel and 15 percent subangular limestone flagstones; finely disseminated calcium carbonate; violently effervescent; strongly alkaline (pH 8.6).

Range in Characteristics

Note: This soil does not have secondary calcium carbonate accumulations
Mean annual soil temperature: 5.6 to 7.8 degrees C
Depth to top of cambic horizon: 5 to 15 centimeters
Thickness of cambic horizon: 40 to 70 centimeters

A horizon:
Hue—7.5YR or 10YR, dry or moist
Value—4 or 5 dry; 3 or 4 moist

Chroma—2 or 3, dry or moist
Clay content—20 to 25 percent
Rock fragments—15 to 25 percent limestone gravel
Calcium carbonate equivalent—15 to 25 percent
Reaction—pH 7.9 to 8.5

Bw1 and Bw2 horizons:
Hue—7.5YR or 10YR, dry or moist
Value—4 to 6 dry; 3 to 5 moist
Chroma—3 or 4, dry or moist
Texture—loam or sandy clay loam
Clay content—20 to 27 percent
Rock fragments—15 to 30 percent (15 to 30 percent limestone gravel and 0 to 10 percent limestone flagstones)
Calcium carbonate equivalent—25 to 35 percent
Sodium adsorption ratio—3 to 8 percent
Reaction—pH 8.2 to 8.8

C horizon:
Hue—7.5YR or 10YR, dry or moist
Value—5 to 7 dry; 4 to 6 moist
Chroma—2 or 3, dry or moist
Texture—loam or sandy clay loam
Clay content—20 to 27 percent
Rock fragments—35 to 50 percent (20 to 35 percent limestone gravel and 10 to 25 percent limestone flagstones)
Calcium carbonate equivalent—35 to 45 percent
Sodium adsorption ratio—3 to 8 percent
Reaction—pH 8.2 to 8.8

Ulric Series

Landform: Hills
Elevation: 2,000 to 2,200 meters
Slope: 3 to 35 percent
Parent material: Slope alluvium or colluvium over residuum derived from interbedded sandstone and shale
Mean annual precipitation: 275 to 380 millimeters with peak periods of precipitation occurring from March to June
Mean annual air temperature: 4.5 to 6.5 degrees C
Frost-free period: 60 to 90 days
Drainage class: Well drained
Depth class: Moderately deep

Taxonomic Classification

Fine, smectitic, frigid Torrertic Haplustalfs

Typical Pedon

Ulric loam, in rangeland; Lincoln County, Wyoming; lat. 41 degrees 50 minutes 20.88 seconds N. and long. 110 degrees 46 minutes 42.66 seconds W.; NAD83, UTM 518389 meters E, 4631939 meters N, zone 12. (Colors are for dry soil unless otherwise noted.)

A—0 to 16 centimeters; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; common very fine and few fine roots throughout; common very fine and fine irregular

pores; 10 percent subangular gravel; finely disseminated calcium carbonate; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary. (10 to 18 centimeters thick)

Btk—16 to 47 centimeters; very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; weak medium prismatic structure parting to strong fine subangular blocky; moderately hard, firm, moderately sticky and moderately plastic; few very fine and fine roots throughout; common very fine and fine dendritic tubular pores; 10 percent subangular gravel; 30 percent distinct clay films on all faces of peds; 8 percent fine distinct irregular carbonate masses in matrix and finely disseminated calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (20 to 45 centimeters thick)

BCk—47 to 84 centimeters; very pale brown (10YR 7/3) paragravelly clay, pale brown (10YR 6/3) moist; weak coarse subangular blocky structure; moderately hard, firm, moderately sticky and moderately plastic; few very fine roots throughout; few very fine and fine dendritic tubular pores; 25 percent weakly cemented angular paragravel; 4 percent medium distinct irregular carbonate masses in matrix and finely disseminated calcium carbonate; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary. (20 to 60 centimeters thick)

Cr—84 centimeters; weakly cemented calcareous shale.

Range in Characteristics

Mean annual soil temperature: 5.5 to 7.5 degrees C
Depth to top of argillic horizon: 10 to 18 centimeters
Depth to secondary calcium carbonate accumulation: 10 to 18 centimeters
Depth to paralithic contact: 50 to 100 centimeters

A horizon:

Hue—7.5YR or 10YR, dry or moist
Value—4 to 6 dry; 3 to 5 moist
Chroma—2 to 3, dry or moist
Clay content—20 to 26 percent
Rock fragments—5 to 15 percent gravel
Calcium carbonate equivalent—1 to 3 percent
Reaction—pH 7.6 to 8.0

Btk horizon:

Hue—7.5YR or 10YR, dry or moist
Value—5 to 7 dry; 4 or 5 moist
Chroma—3 or 4, dry or moist
Texture—clay or clay loam
Clay content—35 to 45 percent
Rock fragments—5 to 15 percent gravel
Calcium carbonate equivalent—5 to 10 percent
Reaction—pH 7.9 to 8.4

BCk horizon:

Hue—7.5YR or 10YR, dry or moist
Value—5 to 7, dry or moist
Chroma—3 or 4, dry or moist
Texture—clay or clay loam
Clay content—35 to 45 percent
Parafragments—15 to 30 percent shale paragravel
Calcium carbonate equivalent—10 to 15 percent
Reaction—pH 8.0 to 8.4

Formation of the Soils

This section relates the soils in Fossil Butte National Monument to the major factors of soil formation.

Factors of Soil Formation

By Susan Burlew Southard, James Bauchert, and Jason Martin, Natural Resources Conservation Service.

Soil covers the surface of the earth as a three-dimensional body of varying thickness. It is made up of different proportions of organic and mineral material with pore space filled with gases and water. Soils differ in their appearance, productivity, and management requirements due to their chemical and physical properties. The characteristics and properties of soils are determined by physical and chemical processes that result from the interaction of five soil-forming factors. These factors of soil formation are interdependent, and few generalizations can be made regarding any one factor unless the effects of the other factors are known. The term “pedogenesis” is often used to connote the processes of soil formation.

The interacting soil-forming factors are parent material, climate, organisms, time, and relief or topography. *Parent material* is the source material in which soils form. Soils are influenced by the texture and structure of the parent material and its mineralogical and chemical composition. *Climate* is predominantly the temperature and kind and amount of precipitation. Climate is also the seasonal distribution of temperature and precipitation. *Organisms* are the plants and other organisms living in and on the soil, including humans. *Time* refers to how long the soil-forming factors have been operating on a particular landscape. *Relief* or *topography* is the shape and elevation of the landscape. It affects internal and external soil properties, such as soil drainage, aeration, susceptibility to erosion, and exposure to the sun and wind (Jenny, 1941).

The processes of soil formation are sequences of events involving biogeochemical reactions that are energized by climate and spatially related to relief or topography (Buol et al., 2011). The physical and chemical properties of a soil are altered by these reactions over time. The influence of any one of these factors varies among all parks and within localities of a particular park. Soils may differ significantly from place to place in a park and within very short distances as a result of complex interaction among the five factors. In some cases, however, parks may have vast stretches of the same type of soil because of uniform soil-forming factors.

Setting of Fossil Butte National Monument (Fossil Butte NM)

Understanding the geomorphic setting and geologic resources of a park helps in understanding the parent materials from which the park soils formed. In addition, understanding the soils of southwestern Wyoming enhances the understanding of the unique relationship between soils, plants, and the environment. Soil-forming processes are influenced by rock type, topographic expression, and the surface and hydrologic properties of the area. Soil formation processes influence soil properties and behavior, which may help to determine best management practices.

Figure 1.—The headwaters of the Bear River are in the snowcapped Uinta Mountains to the south of Fossil Butte National Monument. View is to the south from the highest elevation in the park. The gently sloping mesas in the foreground and middle ground are mapped as Cundick and Fossilbutte soils (map unit 10008).

Fossil Butte NM is located in southwestern Wyoming on the western edge of the Great Plains. It is in a small intermontane basin nestled between the Tunp Range and Commissary Ridge. It is in close proximity to Twin Creek, a tributary to the larger Upper Bear River watershed (fig. 1). Chicken Creek flows southward through the monument.

Parent Material

Parent material is the unconsolidated mass in which soils form. Mineral soil parent material is a product of the weathering of underlying bedrock in place or the weathering of material that has been transported. Organic soils form in place from the accumulation and decomposition of plant material, such as wood, leaves, and aquatic plants. Weathering refers to the chemical and physical disintegration and decomposition of parent material. Few soils weather directly from the underlying rocks. More commonly, soils form in materials that have moved in from elsewhere. Soils generally have a dominant kind of parent material but are influenced by other types of parent material. Material may have been moved only a few feet by gravity (colluvial parent material) or transported long distances by wind (eolian parent material) or by water (alluvial parent material). Soils that have residual parent material formed directly from underlying rocks or from an *in situ* plant source. Soils that formed in residuum may have the same general chemistry as the original rocks, depending on the degree of weathering that has occurred.

The soils in Fossil Butte NM formed predominantly in alluvium, residuum, and colluvium derived from the red, purple, yellow, and gray sandstone and claystone beds of the Wasatch Formation and the overlying Fossil Butte Member of the predominantly buff-colored Green River Formation (Graham, 2012). The 50-million-year-old Wasatch Formation contributed to the development of fine textured soils. The Fossil Butte Member of the Green River Formation overlies the Wasatch Formation. It is dominated

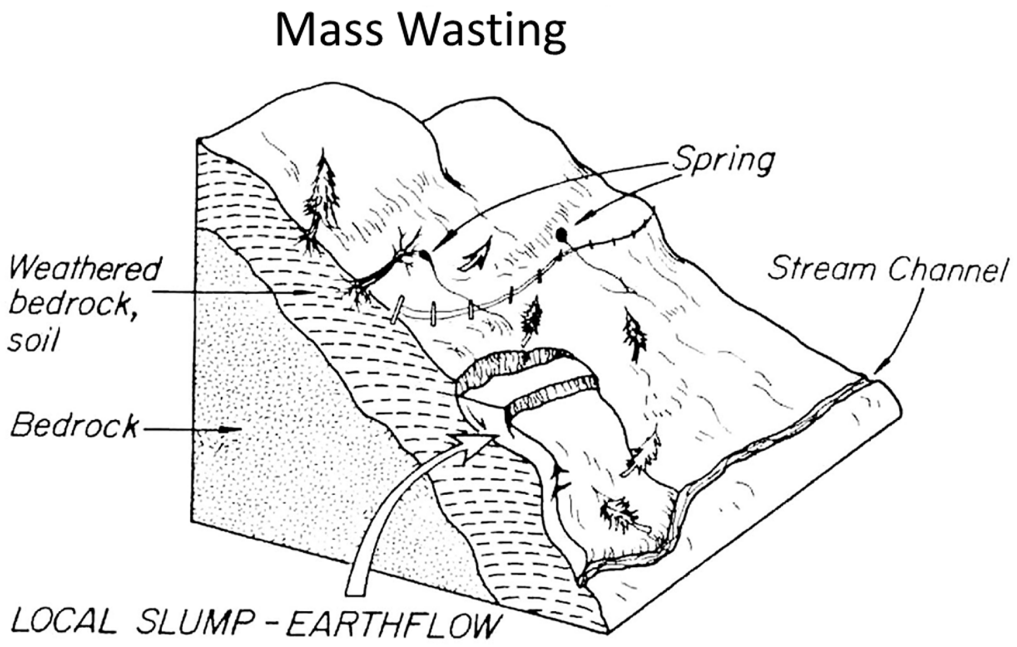


Figure 2.—Mass movement (or mass wasting) is common in the park near springs located at the contact between the Wasatch and Green River Formations.

by marlstone, limestone, and carbonatic siltstone—the parent materials of calcareous loamy soils. Table 4 and the detailed soil map unit descriptions list the predominant parent material for the major soils of each map unit in the park.

The lowest stratum in the Green River Formation includes drab brown mudstone. The soils associated with this formation tend to be loamy and have a variable content of calcium carbonate. Where the two geologic formations meet, water moves laterally and seeps out of the side of escarpments and hills. This perched wetness contributes to mass wasting through the development of rotational slides (figs. 2, 3, and 4). Rotational slides have a curved and typically concave slip face. Moist rotational slides near the point of seepage tend to create darkened surface horizons (i.e., mollic epipedons) while drier rotational slides are much less developed in terms of carbon accumulation. Landslides in the Green River Formation formed the cliffs of Fossil Butte and Cundick Ridge. Slow-moving earth flows continue to disturb the mudstone and siltstone strata of the Wasatch Formation, particularly south of Cundick Ridge.

Interspersed among areas of Babb soils are Chickenhill and Gunsone soils mapped in a complex. A map unit complex consists of two or more dissimilar components that occur in a consistent, repeating pattern but cannot be separated at the mapping scale, which is 1:24,000 for this survey. Chickenhill soils are on upper backslopes and shoulder slopes, and Gunsone soils are on mid and lower backslopes. Gunsone soils are in a Dense Clay ecological site, and Chickenhill soils are in a Shallow Clayey ecological site (see table 5).

The slides and earth flows contributed to soils that formed from colluvium and slope alluvium, including Babb, Redsage, Rootel, and Swiftcreek soils. These soils have inherited the physical properties of the parent material. They are loamy or clayey and commonly have a high content of soil carbonate. They commonly lack significant profile development due to unstable landscape positions.

Mudstone in the Wasatch Formation contains clay minerals called smectites that expand when wet and shrink upon drying. This swell-shrink process destabilizes slopes and increases the potential for mass movement, such as rockfall, landslides,

Figure 3.—Seeps and springs (light green areas) have contributed to mass movement and soil development in the park. The mesa landscape in the foreground is mapped as Cundick and Fossilbutte soils.

Figure 4.—Landslides below Fossil Butte have created unstable slopes and soils that are easily eroded. Seeps, slumps, and aspen-covered areas east of Chicken Creek are derived from deposits from mass movement, which created the cliffs on Fossil Butte. Aspens grow in the rotational slide areas and are mapped as Babb soils.

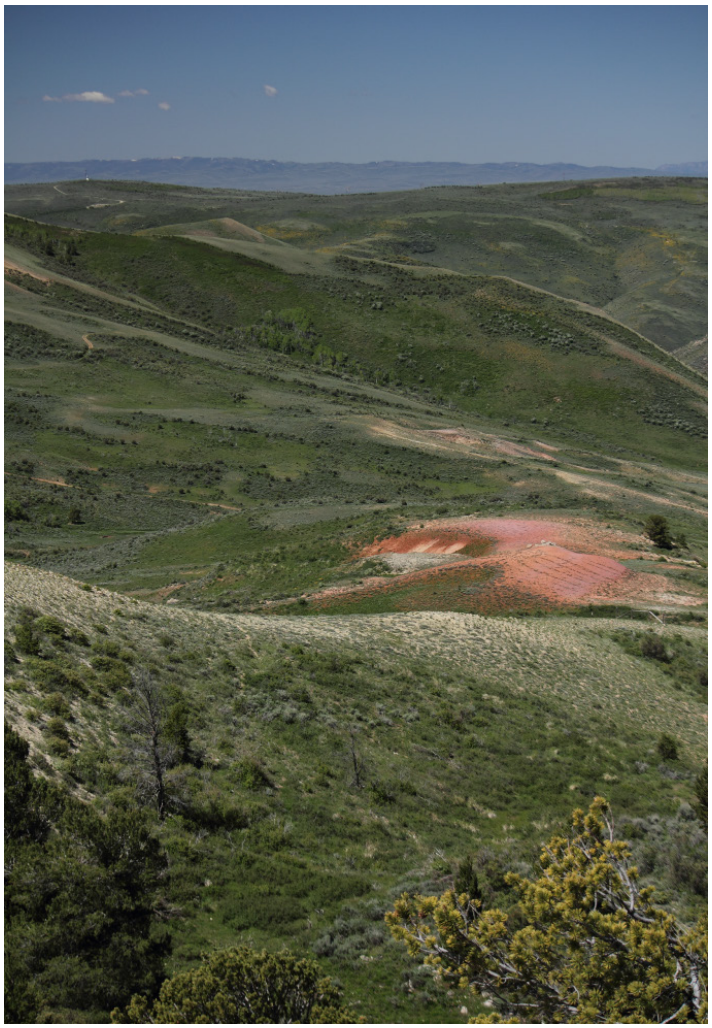


Figure 5.—Exposures of the Wasatch Formation are typically mapped as Ulric or Gunsone soils. The series type locations for Ulric and Gunsone are located within the park. Both series have smectitic mineralogy.

and slumps. The Wasatch Formation clays in strata and soils become saturated and slump, and the more solid Green River Formation limestone is carried along on top of the collapsing clay soil. Table 20 shows the soils that have smectitic mineralogy, and table 14 lists soils that have a very high shrink-swell potential. Seven of the 16 soils identified in the park have smectitic mineralogy (fig. 5). The smectitic mineralogy commonly creates limitations for some uses, such as building sites (see tables 8 and 9). The shrink-swell potential of smectitic soils can be strong enough to cause foundations to move and crack, sidewalks to heave, and infrastructures to fall apart. Visible cracks on the soil surface are very common during dry seasons. The cracks close when the soil is moist.

Alluvium is parent material deposited by running water (figs. 6 and 7). It can have different textures, depending on whether the water moves quickly or slowly. The type of rocks occurring in the source region of the streams and rivers also determine its characteristics. Fast-moving water deposits gravel, rocks, and sand. Slow-moving water leaves fine textured deposits (clay and silt) when sediments in the water settle out.

Figure 6.—Alluvial fans at the lowest elevations in the park (foreground and center) are mapped predominantly as Gerdrum soils.

Soils associated with the alluvial landscape of Chicken Creek have active hydrology and support hydrophytic vegetation. Bearbou soils are a major hydric soil mapped in wetland areas of the drainage. These soils are derived predominantly from very clayey alluvium that was deposited in the intermontane basin. Due to the nature of the rock strata from which the alluvial soils formed, all of these soils have a very high content of clay and smectitic mineralogy. The location of these soils on the low-lying flood plains also contributes to their saline chemistry.

All of the soils in the park have some calcium carbonates due to the influence of limestone and marl in the Green River Formation. Some carbonates are assumed to be from windblown carbonatic dust, or loess. Calcic horizons are concentrations of calcium carbonates that have moved through the soil by water through a process called leaching. Most soils in Fossil Butte NM have calcic horizons due to the carbonate source in the parent material strata. Some park soils are calcareous to the surface while others have been leached of carbonates in surface horizons. Quakenasp and Ducktail soils have been leached of carbonates in the surface horizons and have very low pH even though they formed from limestone (see table 19). These soils are predominantly on north aspects with mixed Douglas fir and aspen. Because of more effective moisture (north aspects retain soil moisture and snow slowly melts into the soil) and the effects of vegetation, Quakenasp and Ducktail soils have surface horizons with a high content of organic matter (i.e., mollic epipedons) and zones of clay accumulation in the subsoil (i.e., argillic horizons). Conifers acidify soil through needle drop and because they lack the basic element nutrient cycling that deciduous trees perform. The soil-plant-aspect relationships in Fossil Butte NM are common in the landscapes of southwestern Wyoming and northern Utah that are derived from the Green River Formation. The leached carbonates in Ducktail and Quakenasp soils have moved into pronounced calcic horizons with inorganic carbon accumulation.

Soil inorganic carbon (SIC) is carbon found in soil carbonates, typically as calcium carbonate layers in the soil or as clay-sized fractions throughout the soil. Carbonates

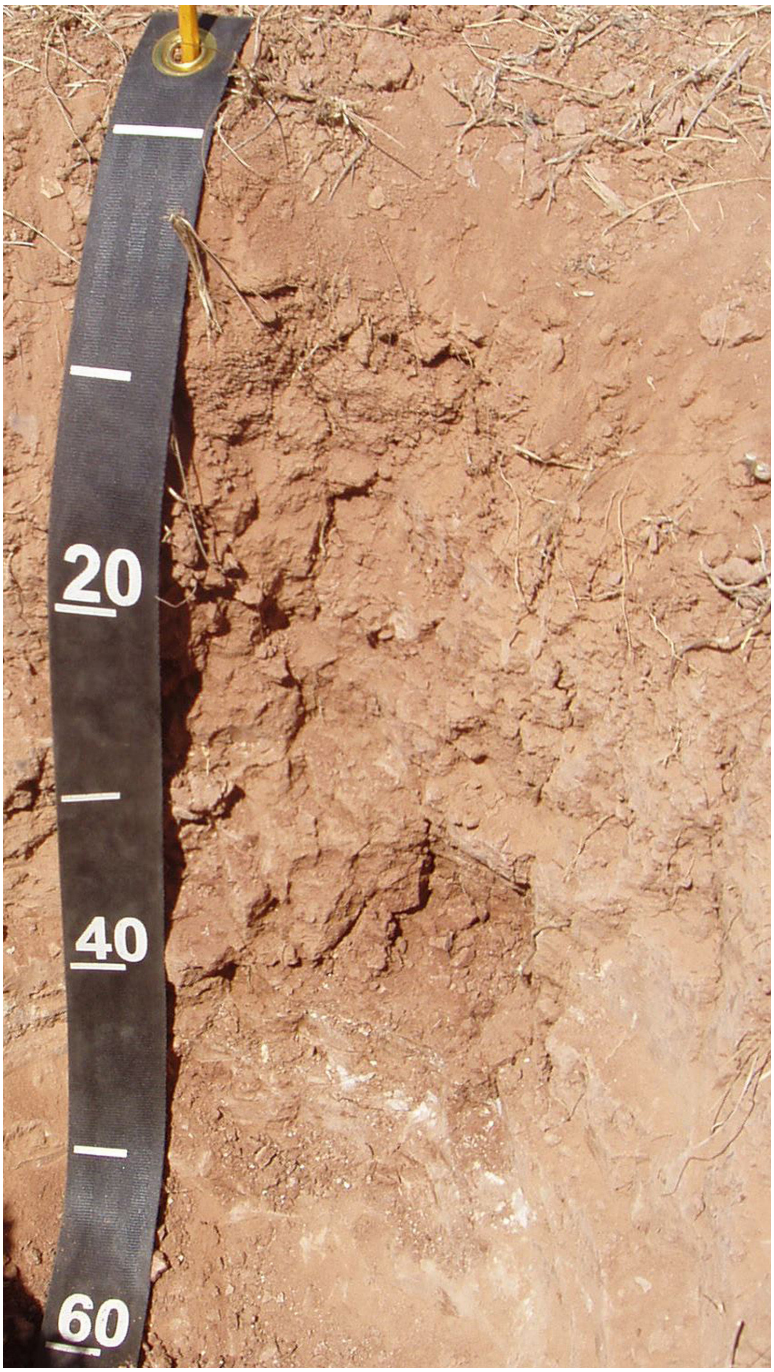


Figure 7.—Profile of a Gerdrum soil. Gerdrum soils are sodium affected. In map unit 85C, they are correlated to the Saline Upland ecological site.

in soils are found in areas where evaporation rates exceed precipitation, as is the case in most arid and semi-arid environments. The carbonates in soils commonly accumulated from solution when wetter climates existed. Carbonate C is measured by treating the soil with HCl and then measuring the evolved CO_2 with a manometer. Based on soil survey data of Fossil Butte NM, soil carbon in the park soils is mostly in the inorganic form as calcium carbonate. Swiftcreek soils (fig. 8) have the highest

Figure 8.—Profile of a Swiftcreek soil. Swiftcreek soils formed in limestone and are strongly or violently effervescent with 1 N HCl throughout. Effervescence indicates the presence of carbonates in the soil.

values, 80 kg/m^2 (or 356 tons/acre), which exceed the organic carbon form by 10 times (see table 16).

Climate

Differences in climate can result in differences in soils. Temperature and moisture influence soil formation and are the two most commonly measured features of climate. Weathering is most active when soils are moist and warm because these conditions are conducive to rapid chemical reactions and increased biological activity in the soil. Cooler temperatures result in slower chemical reactions. While average temperatures

Figure 9.—Dry western-facing slopes in the park have sparse vegetation and are typically mapped as Gunsone soils in map unit 10004.

and precipitation are important in determining soil properties, the extremes of climate in any given locale also play a major role in soil formation.

Wind redistributes sand, salts, and carbonates and other particles in arid and semi-arid regions. The soils of the park formed, and are still forming, in a dry climate with limited precipitation (fig. 9). Some of the soils, such as Redsage and Rootel, are calcareous to the surface because there is not enough rainfall to leach the carbonates from the soil and because present-day winds constantly add more carbonates to the soil. During periods of rainfall or snowmelt, water carrying dissolved or suspended solids moves through soil in a process called leaching. Leaching becomes active with the onset of rainfall or snowmelt. The arid climate of Fossil Butte NM limits the leaching process. This process is most pronounced at the higher elevations and on north-facing slopes.

Present-day climate variations are the result of topography and relief. In most areas of the United States, temperature generally decreases with elevation and precipitation generally increases with elevation. As the amount of precipitation increases, the extent of leaching and the amount of vegetation generally increase to a point where they then decrease because of decreasing temperatures. Fluctuations in temperature and moisture affect the rate of organic matter production, decomposition, and accumulation and the weathering of minerals. Due to its small size, the overall climatic regime of the park is fairly uniform, although soil climate changes with elevation.

The climate in Fossil Butte NM is generally characterized by cold winters and temperate, dry summers that may feature sporadic convective thunderstorms. Elevation changes radically from 6,600 feet in the southwest corner of the park to 8,084 feet in the northern part. The number of frost-free days ranges from 30 on north-facing, high-elevation slopes to 105 in areas at the lower elevations. Mean annual temperature ranges from 36 degrees F on north-facing, high-elevation slopes to 44 degrees F at the lower elevations.

Figure 10.—The coldest soils in the park have steep, north aspects that are vegetated with Douglas fir, aspen, and limber pine. Two new soil series are identified in the park on these landscapes—Quakenasp and Ducktail (which occur in map unit 10001).

Precipitation generally increases with elevation and ranges from 9 inches to 24 inches annually. Higher effective precipitation and cooler temperatures on north-facing slopes contribute to a cryic temperature regime (fig. 10); cryic soils can also occur at high elevations, on top of buttes and ridges. Soils in the frigid temperature regime tend to be aridic ustic in the lower hills near the Visitor Center and the quarry trail and typic ustic in the higher hills near the Chicken Creek trailhead and in the hills directly below the base of Cundick Ridge and Fossil Butte.

Organisms

Plants, animals, micro-organisms, and humans affect the formation of soils. Plants capture solar energy via photosynthesis and transfer that energy to soil. This energy is a fundamental driver of many soil processes. Fungi and bacteria are the primary organisms that decompose organic matter and add nutrients to the soil. Animals and micro-organisms mix soils and form burrows and pores. Plant roots open channels in the soils. Abandoned animal burrows commonly are filled with loose material from the overlying horizons and transmit water more readily than the surrounding undisturbed soil material.

Different types of roots have different effects on soils. Grass roots are fibrous and decompose easily, adding organic matter to the soil. Fine grass roots can extend below the surface for many feet. Plant roots also help to develop soil structure and aggregate stability. Vegetation increases soil stability by protecting the surface against wind and water erosion. Taproots open pathways through dense layers. Micro-organisms affect chemical exchanges between roots and soil. Humans can mix the soil extensively, such as during fossil excavation. They can also quickly change hydrologic conditions that influence soil properties, such as by building and then removing ranch ponds and dams, which occurred in the Chicken Creek watershed.

The type of organisms that thrive on different soils greatly influences the development of ecological niches in a park. The influence of parent material on soil depth and soil chemistry dictates the types of vegetation growing in different areas. For example, Gerdrum and Absher soils are in Saline Upland and Saline Lowland ecological sites, respectively, that support predominantly saline-tolerant plants. The major grasses include rhizomatous wheatgrass, bottlebrush squirreltail, and Indian ricegrass. Other grasses may include alkali sacaton, needleandthread, and Sandberg bluegrass. Gardners saltbush, bud sagebrush, greasewood, and winterfat are the dominant woody plants. The soils in the Saline Upland ecological site are commonly deep (greater than 20 inches in depth), well drained, and composed of mostly fine alluvium sediment with excess salt and/or sodium. Surface clays may disperse when wetted and inhibit infiltration. Permeability and available water capacity are also restricted. Parent material is sedimentary rock, especially shale. Typically, electrical conductivity ranges from 4 to 16, sodium adsorption ratio ranges from 13 to 20, and pH ranges from 6.6 to 9.6.

In contrast, Babb and Quakenasp soils are in a Populus tremuloides ecological site, have low pH, and are non-saline and non-sodium affected.

Root growth and humification of organic matter can darken soils to a considerable depth. Humification occurs when leaves, wood, roots, and animals are decomposed by micro-organisms and converted to humic substances. Humic substances are broadly defined products of organic matter decomposition that are relatively resistant to further microbial decomposition. Humic substances with a high carbon content can persist in the soil for a long time, hundreds to thousands of years. Some examples of humic substances are humic and fulvic acids and humins. Humification is common in prairies where there is prolific root growth of native grasses. Native grasses contributed to the soil organic matter content in upland positions in the park.

Soil organic matter makes up about twice the weight of soil organic carbon (SOC). SOC is found in organic and mineral soil layers (horizons). Soil horizons are named O, A, B, or C. O horizons have high organic carbon levels and very little mineral content, and C horizons commonly have the least amount of soil organic carbon and high mineral content. Ducktail soils, which are mapped on north-facing slopes under Douglas fir, have the highest content of soil organic carbon (SOC) in the park (see table 16). Soil organic carbon is carbon (C) in soil that originated from a biological source, such as plants, animals, or micro-organisms. SOC refers only to the carbon occurring in soil organic matter. Duckttail soils have 22 kg/m^2 of SOC, which equates to 98 tons of SOC per acre of sequestrated carbon.

The native vegetation depends on climate, topography, and biological factors plus many soil factors, such as soil density, depth, chemistry, temperature, and moisture. Leaves from plants fall to the surface and decompose on the soil. Organisms decompose these leaves and mix them with the upper part of the soil, which results in the cycling of nutrients and energy back to vegetation.

Time

Time for parent material, climate, organisms, and relief to interact is also a soil-forming factor. Over time, soils exhibit features that reflect the interaction of other soil-forming factors. Recently deposited material, such as material deposited by a flood, exhibits no features from soil development activities and soil properties are mostly inherited from the new material. The previous soil surface and underlying horizons become buried. The time clock resets for these soils. The different horizons in a soil profile and the degree of development can be directly related to time. Terraces above the active flood plain, while similar in origin to the flood plain, are older land surfaces of old abandoned flood plains. Therefore, soils on these terraces exhibit more horizon development. At Fossil Butte NM, Absher soils, which occur on terraces, have a subsoil zone of clay accumulation whereas Bearbou soils, which occur on flood plains,

Figure 11.—Landslide-prone landscapes with unstable soils commonly have a rumpled, hummocky relief.

do not. Soils on the youngest geomorphic surfaces, generally on alluvial fans, and on flood plains associated with rivers and streams have little development. Soils mapped along the active stream corridors typically have no distinctive characteristics and no diagnostic subsurface horizons.

The lack of horizonation in most soils along the Fossil Butte escarpment reflects a minimal degree of pedogenesis due to the dynamic, changing landscape.

Topography and Relief

Topography refers to the shape of the landscape, and relief refers to differences in elevation. The overall landscape in a park, whether it consists of flat flood plains, rolling hills, or steep escarpments is the result of erosion and depositional processes. These processes may have occurred in response to changes in climate, fluctuating sea levels, and/or tectonic activities. Cyclic periods of landscape stability and instability influence the types of soils that form on the landscape (fig. 11). Various erosional and

Figure 12.—Aspect plays a large role in soil formation. On Cundick Ridge, north aspects (image on left) have deep soils under aspen. These soils have a high organic matter content, have low pH in the surface layer, and are leached of carbonates. South-facing slopes in Fossil Butte NM (image on right) have bare exposed slopes and thin soils. These soils have high pH throughout, carbonates at the surface, and a low organic matter content. These two images were taken in close proximity to each other within the park boundary.

depositional landforms dominate the landscape of Fossil Butte NM and include mesas, hillslopes, slides, alluvial fans, and basins. Topography, relief, and landscape position are important factors in soil formation that determine soil properties in the park.

Slope and aspect of the overall landscape can affect the moisture and temperature of the soil (fig. 12). Steep slopes that face the sun are warmer. All steep soils may erode and lose their surface horizons as they form. Thus, these soils may be thinner or exhibit less profile development than the more nearly level ones that receive deposits from areas upslope. Deeper, darker soils may be expected on the bottom land. Soil-forming factors continue to affect soils even on “stable” landscapes. Materials are deposited on their surface, and materials are blown or washed away from the surface. Additions, removals, and alterations are slow or rapid and dependent on climate, landscape position, and biological activity.

Relief influences soil formation mainly through its effect on runoff and erosion. It also influences soil temperature, plant cover, depth to the water table, and the accumulation and removal of organic matter. Because it causes differences in external soil drainage, relief can differentiate soils that formed in the same kind of parent material. Water that runs off the more sloping soils can collect in depressions or drainageways. Ducktail soils formed in residuum and colluvium from limestone on steep slopes formed from constant deposition. The gently sloping Fossilbutte soils are on upland mesas and side slopes and are well drained. The nearly level Absher soils are on alluvial flats and terraces and have accumulated salts in the profile due to evapotranspiration and concentration of salts in shallow water tables.

Most of the soils of Fossil Butte NM are affected by slope instability and high erosion rates, especially if the soil is left unvegetated. The geologic units underlying the slopes of the park contain a heterogeneous mix of shale, siltstone, and limestone. Natural springs have contributed to soil slumps and accelerated erosional processes.

Figure 13.—A level area of Fossil Butte wetlands (foreground) is mapped Bearbou soils, which are classified as hydric soils (see table 3). These soils have been identified in areas of alluvium (an area of map unit 10014 is in the foreground) below the numerous seeps and springs of the park. Identifying these areas is important for park management decisions. In the background is Fossil Butte, capped by fossil-bearing Green River laminated limestone.

Clay-rich units (such as shale and mudstone) may disaggregate when they become saturated with water and are prone to fail when exposed on a slope. Because of the high clay content and mineralogy, soils in these areas tend to form cracks, which lead to piping, erosion, and slope failure. Piping may occur in soils that have subsurface horizons or layers that are more subject to entrainment in moving free water than the surface horizon or layer. The free water enters the soil in places where water ponds due to very gentle slopes and very slow infiltration. The water may flow into soil cracks. Cracks and rodent burrows are examples of macropores that may initiate the piping process. The soil material carried in the moving water moves downward within the soil and may move out of the soil completely if there is an outlet. The result is the formation of pipes which enlarge and coalesce (Soil Survey Division Staff, 1993).

Bearbou soils on low-elevation flood plains are prone to frost action (fig. 13). Frost heave is a natural pedogenic process that mixes and breaks up the soil surface. Table 17 lists the frost heave potential as “frost action,” which is categorized as low, moderate, or high. The properties of Bearbou soils, such as soil moisture and temperature, make them susceptible to frost action. In addition, because these soils occur in a commonly moist landscape position, moisture is available to form ice crystals. Due to this landscape position, Bearbour soils receive cold air drainage that makes them more susceptible to frost and the natural pedogenic process of frost heave. Frost heave results from ice forming beneath the surface of soil during atmospheric freezing conditions. The ice grows in the direction of heat loss, which is vertically toward the surface, starting at the freezing boundary in the soil. A water supply is required to keep feeding the ice crystal growth. The growing ice is restrained by overlying soil, which applies a load that limits its vertical growth and promotes the formation of a lens-shaped area of ice within the soil.

Frost heave can result in road potholes and cracked pavements and foundations. Table 9 lists map units and soils that have a limitation for roads and streets due to frost action. This limitation results in higher maintenance costs for park roads and parking lots.

Relief and topography also influence the location of prime farmland map units. For example, soils on flood plains that are very deep and have no root restrictions are often rated as prime farmland, if irrigated. No soils in Fossil Butte National Monument are designated as prime farmland.

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487–00.

Buol, S.W., R.J. Southard, R.C. Graham, and P.A. McDaniel. 2011. Soil genesis and classification.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Graham, J.P. 2012. Fossil Butte National Monument: Geologic resources inventory report. Natural Resource Report NPS/NRSS/GRD/NRR—2012/587. National Park Service, Fort Collins, Colorado.

Jenny, H. 1941. Factors of soil formation.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Simonson, Roy W. 1959. Outline of a generalized theory of soil genesis. Soil Science Society of America Proceedings 23:152-156.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. Ecological Site Information System. https://esis.sc.egov.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://nsscnt.nssc.nrcs.usda.gov/nfm/

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.ftw.nrcs.usda.gov/glti/NRPH.html

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://soils.usda.gov/technical/

United States Department of Agriculture, Natural Resources Conservation Service. PLANTS database. National Plant Data Center. http://plants.usda.gov

United States Department of Agriculture, Natural Resources Conservation Service. 2004. National forestry handbook.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://soils.usda.gov/survey/geography/mlra/index.html

United States Department of Agriculture, Natural Resources Conservation Service. 2010. Field indicators of hydric soils in the United States, Version 7.0. L.M. Vasilas, G.W. Hurt, and C.V. Noble, eds. USDA-NRCS in cooperation with the National Technical Committee for Hydric Soils.

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Alpha,alpha-dipyridyl. A dye that when dissolved in 1N ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction indicates a type of redoximorphic feature.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface. Runoff, or surface flow of water, from an area.

Ecological site. An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building

up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Ground water. Water filling all the unblocked pores of the material below the water table.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

K_{sat}. Saturated hydraulic conductivity. (See Permeability.)

Leaching. The removal of soluble material from soil or other material by percolating water.

LEP. See Linear extensibility percent.

Linear extensibility (LE). Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^1/_3$- or $^1/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Linear extensibility percent. Refers to the percent change in linear extensibility.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.
Low strength. The soil is not strong enough to support loads.
Major land resource area (MLRA). A geographic area that generally has similar soils, vegetation, water, climate, elevation, relief, and land use characteristics.
Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.
Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.
Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.
Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.
Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.
Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)
Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.
Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.
Parent material. The unconsolidated organic and mineral material in which soil forms.
Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.
Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.
Percolation. The movement of water through the soil.
Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as "saturated hydraulic conductivity," which is defined in the "Soil Survey Manual." In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as "permeability." Terms describing permeability, measured in inches per hour, are as follows:

Extremely slow	0.0 to 0.01 inch
Very slow	0.01 to 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.
pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface

runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saprolite. Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Series, soil. A group of soils that have profiles that are almost alike. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodium adsorption ratio (SAR). A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate

and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

Table 1.—Acres and Hectares of the Map Units

Map symbol	Map unit name	Acres	Hectares
85C	Gerdrum clay loam, 3 to 10 percent slopes	604	245
161	Rock outcrop	1,715	695
2564	Badland-Ulric-Gunsone complex, 15 to 30 percent slopes	521	211
2571E	Cundick-Fossilbutte-Swiftcreek complex, 6 to 20 percent slopes	5,604	2,270
10001	Quakenasp-Ducktail complex, 20 to 80 percent slopes	2,416	978
10003	Mantlemine-Gunsone complex, 3 to 15 percent slopes	1,925	780
10004	Gunsone loam, 3 to 15 percent slopes	312	126
10005	Babb loam, 10 to 25 percent slopes	1,170	474
10006	Chickenhill-Gunsone complex, 10 to 30 percent slopes	4,842	1,961
10007	Swiftcreek gravelly loam, 15 to 50 percent slopes	16,092	6,517
10008	Cundick-Fossilbutte complex, 1 to 6 percent slopes	1,229	498
10012	Redsage-Rootel complex, 8 to 35 percent slopes	971	393
10014	Absher-Bearbou complex, 0 to 3 percent slopes	188	76
	Total	37,589	15,224

Table 2.—Land Capability Classification

(Land capability classification is a system of grouping soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time. Only the soils suitable for cultivation are listed. N indicates nonirrigated areas and I irrigated)

Map unit symbol and component name	Land capability	
	N	I
85C:		
Gerdrum	6s	6s
2564:		
Ulric	6e	---
Gunsone	6e	---
2571E:		
Cundick	6e	---
Fossilbutte	6e	---
Swiftcreek	6e	---
10001:		
Quakenasp	6e	---
Ducktail	7e	---
10003:		
Mantlemine	6e	---
Gunsone	6s	6e
10004:		
Gunsone	6s	---
10005:		
Babb	6e	---
10006:		
Chickenhill	6e	---
Gunsone	6e	---
10007:		
Swiftcreek	7e	---
10008:		
Cundick	6e	6e
Fossilbutte	6e	6e
10012:		
Redsage	6e	---
Rootel	6e	---

Table 2.—Land Capability Classification—Continued

Map unit symbol and component name	Land capability	
	N	I
10014:		
Absher	7s	7s
Bearbou	5w	5w

Table 3.—Hydric Soils

(This report lists only those map unit components that are rated as hydric. Definitions of hydric criteria codes are below)

Map symbol and map unit name	Component	Percent of map unit	Hydric rating	Landform	Hydric soils criteria			
					Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria
10014: Absher-Bearbou complex, 0 to 3 percent slopes	Bearbou	25	Yes	flood plains	2	Yes	No	No

Explanation of hydric criteria codes:

1. All Histels except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, or Andic, Cumulic, Pachic, or Vitrandic subgroups that:
   - A. are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
   - B. are poorly drained or very poorly drained and have either:
     1.) a water table at the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
     2.) a water table at a depth of 0.5 foot or less during the growing season if permeability is equal to or greater than 6.0 in/hr in all layers within a depth of 20 inches, or
     3.) a water table at a depth of 1.0 foot or less during the growing season if permeability is less than 6.0 in/hr in any layer within a depth of 20 inches.
3. Soils that are frequently ponded for long or very long duration during the growing season.
4. Soils that are frequently flooded for long or very long duration during the growing season.

Table 4.—Climate, Landscape, Landform, Parent Material, and Ecological Site

(Miscellaneous nonsoil components are not displayed in this report. Component percents may not add up to 100. MAP is the mean annual precipitation)

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	m	mm				
85C:								
Gerdrum	90	3-10	2000-2100	275-325	Intermontane basin	Alluvial fan	Alluvium derived from shale and siltstone	Saline Upland (Foothills And Basins West), R034AY244WY
2564:								
Ulric	30	15-30	2040-2240	275-325	Foothills	Hill	Colluvium derived from sedimentary rock over residuum weathered from shale	Shallow Clayey (Foothills And Basins West), R034AY258WY
Gunsone	15	15-30	2040-2240	275-325	Foothills	Hill	Colluvium over residuum weathered from shale	Dense Clay (Foothills And Basins West), R034AY210WY
2571E:								
Cundick	45	6-20	2286-2438	325-500	Foothills	Butte and ridge	Slope alluvium over residuum weathered from limestone	Shallow Clayey (Foothills And Basins West), R034AY258WY
Fossilbutte	25	6-20	2286-2438	325-500	Foothills	Mesa and ridge	Slope alluvium derived from sedimentary rock	Mountain Shallow Loam (Low Sagebrush), R047XA442UT
Swiftcreek	15	6-20	2286-2438	325-500	Foothills	Rotational slide	Slide deposits derived from limestone	Coarse Upland (Foothills And Basins West), R034AY208WY
10001:								
Quakenasp	50	20-35	2195-2377	375-500	Foothills	Hill	Colluvium derived from limestone over residuum weathered from shale	Populus tremuloides/ Symphoricarpos oreophilus/Bromus carinatus, F047XA508UT
Ducktail	35	60-80	2195-2377	375-500	Foothills	Escarpment	Colluvium derived from limestone	Pseudotsuga menziesii/Mahonia/Bromus, F047XA532UT

Table 4.—Climate, Landscape, Landform, Parent Material, and Ecological Site—Continued

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	m	mm				
10003:								
Mantlemine	50	3-15	2012-2195	275-330	Intermontane basin	Hill	Slope alluvium over residuum weathered from sandstone and shale	Loamy (Foothills And Basins West), R034AY222WY
Gunsone	30	3-8	2012-2195	275-330	Intermontane basin	Hill	Slope alluvium over residuum weathered from shale	Dense Clay (Foothills And Basins West), R034AY210WY
10004:								
Gunsone	80	3-15	2012-2195	275-330	Intermontane basin	Hill	Slope alluvium over residuum weathered from shale	Dense Clay (Foothills And Basins West), R034AY210WY
10005:								
Babb	80	10-25	2195-2377	350-450	Foothills	Rotational slide	Slide deposits derived from limestone over residuum weathered from shale and siltstone	Populus tremuloides/ Symphoricarpos oreophilus/Bromus carinatus, F047XA508UT
10006:								
Chickenhill	45	10-30	2073-2377	300-350	Foothills	Hill	Slope alluvium over residuum weathered from shale	Shallow Clayey (Foothills And Basins West), R034AY258WY
Gunsone	35	10-30	2073-2377	300-350	Foothills	Hill	Slope alluvium over residuum weathered from shale	Dense Clay (Foothills And Basins West), R034AY210WY
10007:								
Swiftcreek	75	15-50	2195-2377	325-450	Foothills	Rotational slide	Slide deposits derived from limestone	Coarse Upland (Foothills And Basins West), R034AY208WY
10008:								
Cundick	40	1-6	2286-2438	325-500	Foothills	Mesa and ridge	Slope alluvium over residuum weathered from limestone	Mountain Loam (Browse), R047XA420UT
Fossilbutte	35	1-6	2286-2438	325-500	Foothills	Mesa and ridge	Slope alluvium derived from sedimentary rock	Mountain Shallow Loam (Low Sagebrush), R047XA442UT

Table 4.—Climate, Landscape, Landform, Parent Material, and Ecological Site—Continued

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	m	mm				
10012:								
Redsage	65	8-20	1981-2195	250-355	Foothills	Rotational slide	Slide deposits derived from sedimentary rock	Loamy (Foothills And Basins West), R034AY222WY
Rootel	30	15-35	1981-2195	250-355	Foothills	Rotational slide	Slide deposits derived from sedimentary rock over residuum weathered from calcareous sandstone	Shallow Loamy (Foothills And Basins West), R034AY262WY
10014:								
Absher	60	0-3	1981-2134	275-350	Intermontane basin	Stream terrace	Alluvium derived from shale and siltstone	Saline Lowland, Drained (Foothills And Basins West), R034AY240WY
Bearbou	25	0-2	1981-2134	275-350	Intermontane basin	Flood plain	Alluvium derived from shale and siltstone	Wetland (Foothills And Basins West), R034AY278WY

Table 5.—Ecological Site-Soil Correlation

(Only soils and miscellaneous land types with correlated ecological sites are shown)

Map unit symbol, soil name, and percent of map unit	Ecological site name	Ecological site type	Ecological site ID
85C:			
90%-Gerdrum	Saline Upland (Foothills And Basins West)	Rangeland	R034AY244WY
10%-Redsage	Loamy (Foothills And Basins West)	Rangeland	R034AY222WY
2564:			
30%-Ulric	Shallow Clayey (Foothills And Basins West)	Rangeland	R034AY258WY
15%-Gunsone	Dense Clay (Foothills And Basins West)	Rangeland	R034AY210WY
5%-Mantlemine	Loamy (Foothills And Basins West)	Rangeland	R034AY222WY
5%-Redsage	Overflow (Foothills And Basins West)	Rangeland	R034AY230WY
2571E:			
45%-Cundick	Shallow Clayey (Foothills And Basins West)	Rangeland	R034AY258WY
25%-Fossilbutte	Mountain Shallow Loam (Low Sagebrush)	Rangeland	R047XA442UT
15%-Swiftcreek	Coarse Upland (Foothills And Basins West)	Rangeland	R034AY208WY
10%-Reppart	Mountain Loam (Browse)	Rangeland	R047XA420UT
10001:			
50%-Quakenasp	Populus tremuloides/ Symphoricarpos oreophilus/ Bromus carinatus	Forestland	F047XA508UT
35%-Ducktail	Pseudotsuga menziesii/ Mahonia/Bromus	Forestland	F047XA532UT
10%-Swiftcreek	Mountain Loam (Browse)	Rangeland	R047XA420UT
10003:			
50%-Mantlemine	Loamy (Foothills And Basins West)	Rangeland	R034AY222WY
30%-Gunsone	Dense Clay (Foothills And Basins West)	Rangeland	R034AY210WY
10%-Dunlap	Shallow Loamy (Foothills And Basins West)	Rangeland	R034AY262WY
10%-Redsage	Overflow (Foothills And Basins West)	Rangeland	R034AY230WY

Table 5.—Ecological Site-Soil Correlation—Continued

Map unit symbol, soil name, and percent of map unit	Ecological site name	Ecological site type	Ecological site ID
10004:			
80%-Gunsone	Dense Clay (Foothills And Basins West)	Rangeland	R034AY210WY
10%-Mantlemine	Loamy (Foothills And Basins West)	Rangeland	R034AY222WY
10%-Whitesage	Shallow Loamy (Foothills And Basins West)	Rangeland	R034AY262WY
10005:			
80%-Babb	Populus tremuloides/ Symphoricarpos oreophilus/ Bromus carinatus	Forestland	F047XA508UT
10%-Cundick	Loamy (Foothills And Mountains West)	Rangeland	R043BY222WY
5%-Swiftcreek	Coarse Upland (Foothills And Basins West)	Rangeland	R034AY208WY
10006:			
45%-Chickenhill	Shallow Clayey (Foothills And Basins West)	Rangeland	R034AY258WY
35%-Gunsone	Dense Clay (Foothills And Basins West)	Rangeland	R034AY210WY
10%-Mantlemine	Loamy (Foothills And Basins West)	Rangeland	R034AY222WY
5%-Swiftcreek	Coarse Upland (Foothills And Basins West)	Rangeland	R034AY208WY
10007:			
75%-Swiftcreek	Coarse Upland (Foothills And Basins West)	Rangeland	R034AY208WY
10%-Lithic Ustorthents	Shallow Loamy (Foothills And Basins West)	Rangeland	R034AY262WY
10%-Marigold	Loamy (Foothills And Mountains West)	Rangeland	R043BY222WY
10008:			
40%-Cundick	Mountain Loam (Browse)	Rangeland	R047XA420UT
35%-Fossilbutte	Mountain Shallow Loam (Low Sagebrush)	Rangeland	R047XA442UT
10%-Ettienridge	Gravelly (Foothills And Basins West)	Rangeland	R034AY212WY
10%-Reppart	Mountain Loam (Browse)	Rangeland	R047XA420UT
5%-Lyonsbridge	Semidesert Silt Loam (Winterfat)	Rangeland	R047XB244UT
10012:			
65%-Redsage	Loamy (Foothills And Basins West)	Rangeland	R034AY222WY
30%-Rootel	Shallow Loamy (Foothills And Basins West)	Rangeland	R034AY262WY

Table 5.—Ecological Site-Soil Correlation—Continued

Map unit symbol, soil name, and percent of map unit	Ecological site name	Ecological site type	Ecological site ID
10014:			
60%-Absher	Saline Lowland, Drained (Foothills And Basins West)	Rangeland	R034AY240WY
25%-Bearbou	Wetland (Foothills And Basins West)	Rangeland	R034AY278WY
10%-Dillon	Saline Subirrigated (Foothills And Basins West)	Rangeland	R034AY242WY

Table 6.—Land Management, Part I (Planting)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting		Suitability for mechanical planting		Suitability for use of harvesting equipment	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
85C:							
Gerdrum	90	Moderately suited Stickiness; high plasticity index	0.50	Moderately suited Stickiness; high plasticity index Slope	0.50 0.50	Severe Low strength	1.00
161:							
Rock outcrop	100	Not rated		Not rated		Not rated	
2564:							
Badland	45	Not rated		Not rated		Not rated	
Ulric	30	Moderately suited Stickiness; high plasticity index	0.50	Poorly suited Slope Stickiness; high plasticity index	0.75 0.50	Severe Low strength	1.00
Gunsone	15	Moderately suited Stickiness; high plasticity index	0.50	Poorly suited Slope Stickiness; high plasticity index	0.75 0.50	Severe Low strength	1.00
2571E:							
Cundick	45	Well suited		Moderately suited Slope Rock fragments	0.50 0.50	Moderate Low strength	0.50
Fossilbutte	25	Moderately suited Stickiness; high plasticity index	0.50	Moderately suited Slope Stickiness; high plasticity index	0.50 0.50	Severe Low strength	1.00
Swiftcreek	15	Well suited		Moderately suited Slope Rock fragments	0.50 0.50	Moderate Low strength	0.50
10001:							
Quakenasp	50	Moderately suited Stickiness; high plasticity index	0.50	Unsuited Slope Stickiness; high plasticity index	1.00 0.50	Severe Low strength	1.00
Ducktail	35	Moderately suited Slope	0.50	Unsuited Slope Rock fragments	1.00 0.50	Severe Low strength	1.00
10003:							
Mantlemine	50	Well suited		Moderately suited Slope	0.50	Severe Low strength	1.00
Gunsone	30	Moderately suited Stickiness; high plasticity index	0.50	Moderately suited Stickiness; high plasticity index Slope	0.50 0.50	Severe Low strength	1.00

Table 6.—Land Management, Part I (Planting)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting		Suitability for mechanical planting		Suitability for use of harvesting equipment	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10004:							
Gunsone	80	Moderately suited Stickiness; high plasticity index	0.50	Moderately suited Stickiness; high plasticity index Slope	0.50 0.50	Severe Low strength	1.00
10005:							
Babb	80	Well suited		Poorly suited Slope Rock fragments	0.75 0.50	Severe Low strength	1.00
10006:							
Chickenhill	45	Well suited		Poorly suited Slope Rock fragments	0.75 0.50	Severe Low strength	1.00
Gunsone	35	Moderately suited Stickiness; high plasticity index	0.50	Poorly suited Slope Stickiness; high plasticity index	0.75 0.50	Severe Low strength	1.00
10007:							
Swiftcreek	75	Well suited		Unsuited Slope Rock fragments	1.00 0.50	Moderate Low strength	0.50
10008:							
Cundick	40	Well suited		Moderately suited Rock fragments	0.50	Moderate Low strength	0.50
Fossilbutte	35	Moderately suited Stickiness; high plasticity index	0.50	Moderately suited Stickiness; high plasticity index	0.50	Severe Low strength	1.00
10012:							
Redsage	65	Well suited		Moderately suited Slope	0.50	Severe Low strength	1.00
Rootel	30	Well suited		Poorly suited Slope Rock fragments	0.75 0.50	Severe Low strength	1.00
10014:							
Absher	60	Moderately suited Stickiness; high plasticity index	0.50	Moderately suited Stickiness; high plasticity index	0.50	Severe Low strength	1.00
Bearbou	25	Well suited		Well suited		Severe Low strength	1.00

Table 6.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion		Hazard of erosion on roads and trails		Suitability for roads (natural surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
85C:							
Gerdrum	90	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
						Slope	0.50
						Dusty	0.23
161:							
Rock outcrop	100	Not rated		Not rated		Not rated	
2564:							
Badland	45	Not rated		Not rated		Not rated	
Ulric	30	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.21
Gunsone	15	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.21
2571E:							
Cundick	45	Slight		Moderate		Poorly suited	
				Slope/erodibility	0.50	Slope	1.00
						Dusty	0.01
Fossilbutte	25	Slight		Severe		Poorly suited	
				Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.01
Swiftcreek	15	Slight		Moderate		Poorly suited	
				Slope/erodibility	0.50	Slope	1.00
						Dusty	0.01
10001:							
Quakenasp	50	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.01
Ducktail	35	Very severe		Severe		Poorly suited	
		Slope/erodibility	0.95	Slope/erodibility	0.95	Slope	1.00
						Low strength	1.00
						Dusty	0.01
10003:							
Mantlemine	50	Slight		Severe		Moderately suited	
				Slope/erodibility	0.95	Slope	0.50
						Low strength	0.50
						Dusty	0.18

Table 6.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)—Continued

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion		Hazard of erosion on roads and trails		Suitability for roads (natural surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10003:							
Gunsone	30	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
						Slope	0.50
						Dusty	0.21
10004:							
Gunsone	80	Slight		Severe		Moderately suited	
				Slope/erodibility	0.95	Slope	0.50
						Low strength	0.50
						Dusty	0.23
10005:							
Babb	80	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.02
10006:							
Chickenhill	45	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.15
Gunsone	35	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.17
10007:							
Swiftcreek	75	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Dusty	0.08
10008:							
Cundick	40	Slight		Slight		Well suited	
						Dusty	0.01
Fossilbutte	35	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
						Dusty	0.01
10012:							
Redsage	65	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.23
Rootel	30	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
						Dusty	0.23
10014:							
Absher	60	Slight		Slight		Moderately suited	
						Low strength	0.50
						Dusty	0.24

Table 6.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)—Continued

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion		Hazard of erosion on roads and trails		Suitability for roads (natural surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10014:							
Bearbou	25	Slight		Slight		Poorly suited	
						Wetness	1.00
						Low strength	0.50
						Flooding	0.50
						Dusty	0.23

Table 6.—Land Management, Part III (Site Preparation)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep)		Suitability for mechanical site preparation (surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value
85C:					
Gerdrum	90	Well suited		Well suited	
161:					
Rock outcrop	100	Not rated		Not rated	
2564:					
Badland	45	Not rated		Not rated	
Ulric	30	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
Gunsone	15	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
2571E:					
Cundick	45	Unsuited		Well suited	
		Restrictive layer	1.00		
Fossilbutte	25	Well suited		Well suited	
Swiftcreek	15	Well suited		Well suited	
10001:					
Quakenasp	50	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
Ducktail	35	Unsuited		Unsuited	
		Slope	1.00	Slope	1.00
10003:					
Mantlemine	50	Well suited		Well suited	
Gunsone	30	Well suited		Well suited	
10004:					
Gunsone	80	Well suited		Well suited	
10005:					
Babb	80	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
10006:					
Chickenhill	45	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
Gunsone	35	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
10007:					
Swiftcreek	75	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50

Table 6.—Land Management, Part III (Site Preparation)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep)		Suitability for mechanical site preparation (surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10008:					
Cundick	40	Unsuited Restrictive layer	1.00	Well suited	
Fossilbutte	35	Well suited		Well suited	
10012:					
Redsage	65	Well suited		Well suited	
Rootel	30	Poorly suited Slope	0.50	Poorly suited Slope	0.50
10014:					
Absher	60	Well suited		Poorly suited Stickiness; high plasticity index	0.50
Bearbou	25	Well suited		Well suited	

Table 6.—Land Management, Part IV (Site Restoration)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire		Potential for seedling mortality	
		Rating class and limiting features	Value	Rating class and limiting features	Value
85C:					
Gerdrum	90	Low		High	
				Available water	1.00
				Soil reaction	1.00
				Salinity	0.50
161:					
Rock outcrop	100	Not rated		Not rated	
2564:					
Badland	45	Not rated		Not rated	
Ulric	30	Low		High	
				Available water	1.00
Gunsone	15	Low		High	
				Available water	1.00
2571E:					
Cundick	45	Low		Moderate	
				Soil reaction	0.50
				Available water	0.50
Fossilbutte	25	Low		Moderate	
				Available water	0.50
Swiftcreek	15	Low		Moderate	
				Soil reaction	0.50
				Carbonate content	0.50
				Available water	0.50
10001:					
Quakenasp	50	Low		Low	
Ducktail	35	Low		Moderate	
				Carbonate content	0.50
10003:					
Mantlemine	50	Low		Moderate	
				Available water	0.50
Gunsone	30	Low		Moderate	
				Available water	0.50
10004:					
Gunsone	80	Low		Moderate	
				Available water	0.50
10005:					
Babb	80	Low		Moderate	
				Carbonate content	0.50
				Available water	0.50

Table 6.—Land Management, Part IV (Site Restoration)—Continued

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire		Potential for seedling mortality	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10006:					
Chickenhill	45	Low		High	
				Available water	1.00
				Carbonate content	0.50
				Soil reaction	0.50
Gunsone	35	Low		High	
				Available water	1.00
10007:					
Swiftcreek	75	Low		Moderate	
				Soil reaction	0.50
				Carbonate content	0.50
10008:					
Cundick	40	Low		Moderate	
				Soil reaction	0.50
				Available water	0.50
Fossilbutte	35	Low		Moderate	
				Available water	0.50
10012:					
Redsage	65	Low		Moderate	
				Available water	0.50
				Soil reaction	0.50
Rootel	30	Low		High	
				Available water	1.00
				Soil reaction	0.50
10014:					
Absher	60	Low		High	
				Available water	1.00
				Soil reaction	1.00
				Salinity	0.50
Bearbou	25	Low		High	
				Wetness	1.00

Table 7.—Recreation, Part I (Camp and Picnic Areas)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Camp areas		Picnic areas	
		Rating class and limiting features	Value	Rating class and limiting features	Value
85C:					
Gerdrum	90	Very limited		Very limited	
		Sodium content	1.00	Sodium content	1.00
		Slow water movement	0.45	Slow water movement	0.45
		Dusty	0.23	Dusty	0.23
161:					
Rock outcrop	100	Not rated		Not rated	
2564:					
Badland	45	Not rated		Not rated	
Ulric	30	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.41	Slow water movement	0.41
		Dusty	0.21	Dusty	0.21
Gunsone	15	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.41	Slow water movement	0.41
		Dusty	0.21	Dusty	0.21
2571E:					
Cundick	45	Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84
		Gravel content	0.39	Gravel content	0.39
		Dusty	0.01	Dusty	0.01
Fossilbutte	25	Somewhat limited		Somewhat limited	
		Slow water movement	0.96	Slow water movement	0.96
		Slope	0.84	Slope	0.84
		Dusty	0.01	Dusty	0.01
Swiftcreek	15	Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84
		Gravel content	0.39	Gravel content	0.39
		Dusty	0.01	Dusty	0.01
10001:					
Quakenasp	50	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.96	Slow water movement	0.96
		Dusty	0.01	Dusty	0.01
Ducktail	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Gravel content	0.12	Gravel content	0.12
		Dusty	0.01	Dusty	0.01

Table 7.—Recreation, Part I (Camp and Picnic Areas)—Continued

Map unit symbol and soil name	Pct. of map unit	Camp areas		Picnic areas	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10003:					
Mantlemine	50	Somewhat limited		Somewhat limited	
		Dusty	0.18	Dusty	0.18
		Slope	0.04	Slope	0.04
Gunsone	30	Somewhat limited		Somewhat limited	
		Slow water movement	0.41	Slow water movement	0.41
		Dusty	0.21	Dusty	0.21
10004:					
Gunsone	80	Somewhat limited		Somewhat limited	
		Slow water movement	0.41	Slow water movement	0.41
		Dusty	0.23	Dusty	0.23
		Slope	0.04	Slope	0.04
10005:					
Babb	80	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Dusty	0.02	Dusty	0.02
10006:					
Chickenhill	45	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Dusty	0.15	Dusty	0.15
Gunsone	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.41	Slow water movement	0.41
		Dusty	0.17	Dusty	0.17
10007:					
Swiftcreek	75	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Gravel content	0.39	Gravel content	0.39
		Dusty	0.08	Dusty	0.08
10008:					
Cundick	40	Somewhat limited		Somewhat limited	
		Gravel content	0.39	Gravel content	0.39
		Dusty	0.01	Dusty	0.01
Fossilbutte	35	Somewhat limited		Somewhat limited	
		Slow water movement	0.96	Slow water movement	0.96
		Dusty	0.01	Dusty	0.01
10012:					
Redsage	65	Somewhat limited		Somewhat limited	
		Slope	0.96	Slope	0.96
		Dusty	0.23	Dusty	0.23
Rootel	30	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Dusty	0.23	Dusty	0.23

Table 7.—Recreation, Part I (Camp and Picnic Areas)—Continued

Map unit symbol and soil name	Pct. of map unit	Camp areas		Picnic areas	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10014:					
Absher	60	Very limited		Very limited	
		Sodium content	1.00	Sodium content	1.00
		Salinity	0.50	Salinity	0.50
		Slow water movement	0.45	Slow water movement	0.45
		Dusty	0.24	Dusty	0.24
Bearbou	25	Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Flooding	1.00	Slow water movement	0.96
		Slow water movement	0.96	Dusty	0.23
		Dusty	0.23		

Table 7.—Recreation, Part II (Trail Management)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails		Mountain bike and off-road vehicle trails	
		Rating class and limiting features	Value	Rating class and limiting features	Value
85C:					
Gerdrum	90	Somewhat limited		Somewhat limited	
		Dusty	0.23	Dusty	0.23
161:					
Rock outcrop	100	Not rated		Not rated	
2564:					
Badland	45	Not rated		Not rated	
Ulric	30	Somewhat limited		Somewhat limited	
		Slope	0.82	Dusty	0.21
		Dusty	0.21		
Gunsone	15	Very limited		Very limited	
		Water erosion	1.00	Water erosion	1.00
		Slope	0.82	Dusty	0.21
		Dusty	0.21		
2571E:					
Cundick	45	Somewhat limited		Somewhat limited	
		Dusty	0.01	Dusty	0.01
Fossilbutte	25	Somewhat limited		Somewhat limited	
		Dusty	0.01	Dusty	0.01
Swiftcreek	15	Somewhat limited		Somewhat limited	
		Dusty	0.01	Dusty	0.01
10001:					
Quakenasp	50	Very limited		Somewhat limited	
		Slope	1.00	Slope	0.08
		Dusty	0.01	Dusty	0.01
Ducktail	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Dusty	0.01	Dusty	0.01
10003:					
Mantlemine	50	Somewhat limited		Somewhat limited	
		Dusty	0.18	Dusty	0.18
Gunsone	30	Somewhat limited		Somewhat limited	
		Dusty	0.21	Dusty	0.21
10004:					
Gunsone	80	Very limited		Very limited	
		Water erosion	1.00	Water erosion	1.00
		Dusty	0.23	Dusty	0.23
10005:					
Babb	80	Somewhat limited		Somewhat limited	
		Slope	0.08	Dusty	0.02
		Dusty	0.02		

Table 7.—Recreation, Part II (Trail Management)—Continued

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails		Mountain bike and off-road vehicle trails	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10006:					
Chickenhill	45	Somewhat limited		Somewhat limited	
		Slope	0.82	Dusty	0.15
		Dusty	0.15		
Gunsone	35	Very limited		Very limited	
		Water erosion	1.00	Water erosion	1.00
		Slope	0.50	Dusty	0.17
		Dusty	0.17		
10007:					
Swiftcreek	75	Very limited		Somewhat limited	
		Slope	1.00	Slope	0.44
		Dusty	0.08	Dusty	0.08
10008:					
Cundick	40	Somewhat limited		Somewhat limited	
		Dusty	0.01	Dusty	0.01
Fossilbutte	35	Somewhat limited		Somewhat limited	
		Dusty	0.01	Dusty	0.01
10012:					
Redsage	65	Very limited		Very limited	
		Water erosion	1.00	Water erosion	1.00
		Dusty	0.23	Dusty	0.23
Rootel	30	Very limited		Very limited	
		Water erosion	1.00	Water erosion	1.00
		Slope	1.00	Dusty	0.23
		Dusty	0.23		
10014:					
Absher	60	Somewhat limited		Somewhat limited	
		Dusty	0.24	Dusty	0.24
Bearbou	25	Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Dusty	0.23	Dusty	0.23

Table 8.—Dwellings and Small Commercial Buildings

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements		Dwellings with basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
85C:							
Gerdrum	90	Very limited		Somewhat limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	0.97	Shrink-swell	1.00
						Slope	0.88
161:							
Rock outcrop	100	Not rated		Not rated		Not rated	
2564:							
Badland	45	Not rated		Not rated		Not rated	
Ulric	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.59	Shrink-swell	0.59	Shrink-swell	0.59
				Depth to soft bedrock	0.08		
Gunsone	15	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Shrink-swell	0.69	Shrink-swell	1.00
2571E:							
Cundick	45	Somewhat limited		Very limited		Very limited	
		Slope	0.84	Depth to hard bedrock	1.00	Slope	1.00
		Depth to hard bedrock	0.18	Slope	0.84	Depth to hard bedrock	0.18
Fossilbutte	25	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	1.00	Shrink-swell	1.00
		Slope	0.84	Slope	0.84	Slope	1.00
Swiftcreek	15	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.84	Slope	0.84	Slope	1.00
10001:							
Quakenasp	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	0.69	Shrink-swell	0.79	Shrink-swell	0.69
Ducktail	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
10003:							
Mantlemine	50	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.04	Slope	0.04	Slope	1.00
		Shrink-swell	0.02			Shrink-swell	0.02
Gunsone	30	Very limited		Somewhat limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	0.69	Shrink-swell	1.00
						Slope	0.50
10004:							
Gunsone	80	Very limited		Somewhat limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	0.69	Shrink-swell	1.00
		Slope	0.04	Slope	0.04	Slope	1.00

Table 8.—Dwellings and Small Commercial Buildings—Continued

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements		Dwellings with basements		Small commercial buildings	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10005:							
Babb	80	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Depth to saturated zone	0.47		
10006:							
Chickenhill	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Shrink-swell	0.01		
Gunsone	35	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Slope	1.00	Slope	1.00
		Slope	1.00	Shrink-swell	0.69	Shrink-swell	1.00
10007:							
Swiftcreek	75	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
10008:							
Cundick	40	Somewhat limited		Very limited		Somewhat limited	
		Depth to hard bedrock	0.18	Depth to hard bedrock	1.00	Depth to hard bedrock	0.18
Fossilbutte	35	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	1.00	Shrink-swell	1.00
10012:							
Redsage	65	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.96	Slope	0.96	Slope	1.00
Rootel	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Depth to soft bedrock	0.02		
10014:							
Absher	60	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	1.00	Shrink-swell	1.00
				Depth to saturated zone	0.84		
Bearbou	25	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Shrink-swell	1.00	Shrink-swell	1.00	Shrink-swell	1.00

Table 9.—Roads and Streets, Shallow Excavations, and Landscaping

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
85C:							
Gerdrum	90	Very limited		Somewhat limited		Very limited	
		Shrink-swell	1.00	Dusty	0.23	Sodium content	1.00
		Low strength	1.00	Too clayey	0.13	Dusty	0.23
				Unstable excavation walls	0.05		
161:							
Rock outcrop	100	Not rated		Not rated		Not rated	
2564:							
Badland	45	Not rated		Not rated		Not rated	
Ulric	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Low strength	1.00	Dusty	0.21	Dusty	0.21
		Shrink-swell	0.59	Depth to soft bedrock	0.08	Depth to bedrock	0.08
				Unstable excavation walls	0.01		
				Too clayey	0.01		
Gunsone	15	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Dusty	0.21	Dusty	0.21
		Low strength	1.00	Unstable excavation walls	0.01		
				Too clayey	0.01		
2571E:							
Cundick	45	Somewhat limited		Very limited		Somewhat limited	
		Slope	0.84	Depth to hard bedrock	1.00	Slope	0.84
		Frost action	0.50	Slope	0.84	Gravel content	0.39
		Depth to hard bedrock	0.18	Dusty	0.01	Depth to bedrock	0.18
				Unstable excavation walls	0.01	Dusty	0.01
Fossilbutte	25	Very limited		Somewhat limited		Somewhat limited	
		Shrink-swell	1.00	Slope	0.84	Slope	0.84
		Low strength	1.00	Unstable excavation walls	0.13	Dusty	0.01
		Slope	0.84	Too clayey	0.02		
				Dusty	0.01		
Swiftcreek	15	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.84	Slope	0.84	Slope	0.84
		Frost action	0.50	Unstable excavation walls	0.01	Gravel content	0.39
				Dusty	0.01	Dusty	0.01

Table 9.—Roads and Streets, Shallow Excavations, and Landscaping—Continued

Map unit symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10001:							
Quakenasp	50	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Low strength	1.00	Too clayey	0.02	Dusty	0.01
		Shrink-swell	0.69	Unstable excavation walls	0.01		
		Frost action	0.50	Dusty	0.01		
Ducktail	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Unstable excavation walls	0.01	Low exchange capacity	0.50
				Dusty	0.01	Gravel content	0.12
						Dusty	0.01
10003:							
Mantlemine	50	Very limited		Somewhat limited		Somewhat limited	
		Low strength	1.00	Dusty	0.18	Dusty	0.18
		Frost action	0.50	Slope	0.04	Slope	0.04
		Slope	0.04	Unstable excavation walls	0.01		
		Shrink-swell	0.02				
Gunsone	30	Very limited		Somewhat limited		Somewhat limited	
		Shrink-swell	1.00	Dusty	0.21	Dusty	0.21
		Low strength	1.00	Unstable excavation walls	0.01		
				Too clayey	0.01		
10004:							
Gunsone	80	Very limited		Somewhat limited		Somewhat limited	
		Shrink-swell	1.00	Dusty	0.23	Dusty	0.23
		Low strength	1.00	Slope	0.04	Slope	0.04
		Slope	0.04	Unstable excavation walls	0.01		
				Too clayey	0.01		
10005:							
Babb	80	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Depth to saturated zone	0.47	Dusty	0.02
				Dusty	0.02		
				Unstable excavation walls	0.01		
				Too clayey	0.01		
10006:							
Chickenhill	45	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Dusty	0.15	Dusty	0.15
				Unstable excavation walls	0.01		
Gunsone	35	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Slope	1.00	Slope	1.00
		Low strength	1.00	Dusty	0.17	Dusty	0.17
		Slope	1.00	Unstable excavation walls	0.01		
				Too clayey	0.01		

Table 9.—Roads and Streets, Shallow Excavations, and Landscaping—Continued

Map unit symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10007:							
Swiftcreek	75	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Dusty	0.08	Gravel content	0.39
				Unstable excavation walls	0.01	Dusty	0.08
10008:							
Cundick	40	Somewhat limited		Very limited		Somewhat limited	
		Frost action	0.50	Depth to hard bedrock	1.00	Gravel content	0.39
		Depth to hard bedrock	0.18	Dusty	0.01	Depth to bedrock	0.18
				Unstable excavation walls	0.01	Dusty	0.01
Fossilbutte	35	Very limited		Somewhat limited		Somewhat limited	
		Shrink-swell	1.00	Unstable excavation walls	0.13	Dusty	0.01
		Low strength	1.00	Too clayey	0.02		
				Dusty	0.01		
10012:							
Redsage	65	Somewhat limited		Somewhat limited		Somewhat limited	
		Slope	0.96	Slope	0.96	Slope	0.96
		Frost action	0.50	Dusty	0.23	Dusty	0.23
		Low strength	0.22	Unstable excavation walls	0.01		
Rootel	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Frost action	0.50	Dusty	0.23	Dusty	0.23
				Depth to soft bedrock	0.02	Depth to bedrock	0.02
				Unstable excavation walls	0.01		
10014:							
Absher	60	Very limited		Somewhat limited		Very limited	
		Shrink-swell	1.00	Depth to saturated zone	0.84	Sodium content	1.00
		Low strength	1.00	Unstable excavation walls	0.25	Salinity	0.50
				Dusty	0.24	Dusty	0.24
				Too clayey	0.08		
Bearbou	25	Very limited		Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Shrink-swell	1.00	Flooding	0.60	Flooding	0.60
		Frost action	1.00	Unstable excavation walls	0.49	Dusty	0.23
		Flooding	1.00	Dusty	0.23		
		Low strength	1.00	Too clayey	0.18		

Table 10.—Sewage Disposal

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
85C:					
Gerdrum	90	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
161:					
Rock outcrop	100	Not rated		Not rated	
2564:					
Badland	45	Not rated		Not rated	
Ulric	30	Very limited		Very limited	
		Slow water movement	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00		
Gunsone	15	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00		
2571E:					
Cundick	45	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slope	0.84		
		Slow water movement	0.50	Slope	1.00
				Seepage	0.50
Fossilbutte	25	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	0.84		
Swiftcreek	15	Somewhat limited		Very limited	
		Slope	0.84	Slope	1.00
		Slow water movement	0.50	Seepage	0.50
10001:					
Quakenasp	50	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Seepage	0.50
Ducktail	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Seepage, bottom layer	1.00	Seepage	1.00

Table 10.—Sewage Disposal—Continued

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Value	Sewage lagoons: Rating class and limiting features	Value
10003:					
Mantlemine	50	Somewhat limited		Very limited	
		Slow water movement	0.50	Slope	1.00
		Slope	0.04	Seepage	0.50
Gunsone	30	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.92
10004:					
Gunsone	80	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	0.04		
10005:					
Babb	80	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Seepage	0.50
		Depth to saturated zone	0.94	Depth to saturated zone	0.40
10006:					
Chickenhill	45	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00	Seepage	0.50
Gunsone	35	Very limited		Very limited	
		Slow water movement	1.00	Slope	1.00
		Slope	1.00		
10007:					
Swiftcreek	75	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.50	Seepage	0.50
10008:					
Cundick	40	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to hard bedrock	1.00
		Slow water movement	0.50	Seepage	0.50
				Slope	0.08
Fossilbutte	35	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.08
10012:					
Redsage	65	Somewhat limited		Very limited	
		Slope	0.96	Slope	1.00
		Slow water movement	0.50	Seepage	0.50

Table 10.—Sewage Disposal—Continued

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields		Sewage lagoons	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10012:					
Rootel	30	Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00
		Depth to bedrock	1.00	Slope	1.00
		Slow water movement	0.50	Seepage	0.50
10014:					
Absher	60	Very limited		Very limited	
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Slow water movement	1.00		
Bearbou	25	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Depth to saturated zone	1.00	Depth to saturated zone	1.00
		Slow water movement	1.00	Seepage	0.50

Table 11.—Source of Gravel and Sand

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The ratings given for the thickest layer are for the thickest layer above and excluding the bottom layer. The numbers in the value columns range from 0.00 to 0.99. The greater the value, the greater the likelihood that the bottom layer or thickest layer of the soil is a source of sand or gravel. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Gravel source		Sand source	
		Rating class and limiting features	Value	Rating class and limiting features	Value
85C:					
Gerdrum	90	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
161:					
Rock outcrop	100	Not rated		Not rated	
2564:					
Badland	45	Not rated		Not rated	
Ulric	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Gunsone	15	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
2571E:					
Cundick	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Fossilbutte	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Swiftcreek	15	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10001:					
Quakenasp	50	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Ducktail	35	Poor		Fair	
		Bottom layer	0.00	Bottom layer	0.01
		Thickest layer	0.00	Thickest layer	0.06
10003:					
Mantlemine	50	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Gunsone	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

Table 11.—Source of Gravel and Sand—Continued

Map unit symbol and soil name	Pct. of map unit	Gravel source		Sand source	
		Rating class and limiting features	Value	Rating class and limiting features	Value
10004:					
Gunsone	80	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10005:					
Babb	80	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10006:					
Chickenhill	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Gunsone	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10007:					
Swiftcreek	75	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10008:					
Cundick	40	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Fossilbutte	35	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10012:					
Redsage	65	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Rootel	30	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
10014:					
Absher	60	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
Bearbou	25	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

Table 12.—Source of Reclamation Material, Roadfill, and Topsoil

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.00 to 0.99. The smaller the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material		Roadfill source		Topsoil source	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
85C:							
Gerdrum	90	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Sodium content	0.00
		Sodium content	0.00	Shrink-swell	0.39	Too clayey	0.00
				Dusty	0.86		
161:							
Rock outcrop	100	Not rated		Not rated		Not rated	
2564:							
Badland	45	Not rated		Not rated		Not rated	
Ulric	30	Poor		Poor		Poor	
		Low content of organic matter	0.13	Low strength	0.00	Slope	0.00
				Depth to bedrock	0.00	Too clayey	0.18
		Too clayey	0.22	Slope	0.18		
Gunsone	15	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Slope	0.00
		Low content of organic matter	0.13	Slope	0.18	Too clayey	0.11
				Shrink-swell	0.71		
2571E:							
Cundick	45	Poor		Poor		Poor	
		Too alkaline	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Low content of organic matter	0.13	Dusty	0.94	Slope	0.16
Fossilbutte	25	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Low content of organic matter	0.88	Shrink-swell	0.28	Slope	0.16
				Dusty	0.91		
Swiftcreek	15	Poor		Fair		Poor	
		Carbonate content	0.00	Stones	0.75	Rock fragments	0.00
		Low content of organic matter	0.13			Hard to reclaim (rock fragments)	0.16
10001:							
Quakenasp	50	Poor		Poor		Poor	
		Low content of organic matter	0.13	Low strength	0.00	Slope	0.00
				Slope	0.00	Too clayey	0.54
		Too clayey	0.58	Shrink-swell	0.81		
Ducktail	35	Poor		Poor		Poor	
		Low content of organic matter	0.50	Slope	0.00	Slope	0.00
						Rock fragments	0.27
		Carbonate content	0.68				
10003:							
Mantlemine	50	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Slope	0.96
		Low content of organic matter	0.13	Dusty	0.92		

Table 12.—Source of Reclamation Material, Roadfill, and Topsoil—Continued

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material		Roadfill source		Topsoil source	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10003:							
Gunsone	30	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Too clayey	0.11
		Low content of organic matter	0.13	Shrink-swell	0.71	Sodium content	0.78
				Dusty	0.87		
10004:							
Gunsone	80	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Too clayey	0.11
		Low content of organic matter	0.13	Shrink-swell	0.71	Sodium content	0.78
				Dusty	0.87		
10005:							
Babb	80	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Slope	0.00
		Low content of organic matter	0.50	Slope	0.92	Rock fragments	0.30
				Dusty	0.94		
10006:							
Chickenhill	45	Poor		Poor		Poor	
		Low content of organic matter	0.13	Low strength	0.00	Slope	0.00
		Carbonate content	0.84	Slope	0.18	Rock fragments	0.77
				Dusty	0.91		
Gunsone	35	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Slope	0.00
		Low content of organic matter	0.13	Slope	0.50	Too clayey	0.11
				Shrink-swell	0.71		
10007:							
Swiftcreek	75	Poor		Poor		Poor	
		Carbonate content	0.00	Slope	0.00	Slope	0.00
		Low content of organic matter	0.13			Rock fragments	0.00
10008:							
Cundick	40	Poor		Poor		Poor	
		Too alkaline	0.00	Depth to bedrock	0.00	Rock fragments	0.00
		Low content of organic matter	0.13	Dusty	0.94	Depth to bedrock	0.82
Fossilbutte	35	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Low content of organic matter	0.88	Shrink-swell	0.28		
				Dusty	0.91		
10012:							
Redsage	65	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Slope	0.04
		Low content of organic matter	0.13	Dusty	0.89	Rock fragments	0.64
Rootel	30	Poor		Poor		Poor	
		Too alkaline	0.00	Depth to bedrock	0.00	Slope	0.00
		Low content of organic matter	0.13	Slope	0.00	Rock fragments	0.29
				Dusty	0.89		

Table 12.—Source of Reclamation Material, Roadfill, and Topsoil—Continued

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material		Roadfill source		Topsoil source	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
10014:							
Absher	60	Poor		Poor		Poor	
		Too alkaline	0.00	Low strength	0.00	Sodium content	0.00
		Sodium content	0.00	Shrink-swell	0.19	Salinity	0.00
				Dusty	0.84		
Bearbou	25	Poor		Poor		Poor	
		Low content of organic matter	0.13	Wetness	0.00	Wetness	0.00
		Too clayey	0.53	Low strength	0.00	Too clayey	0.41
				Shrink-swell	0.23		

Table 13.—Engineering Properties

(Data for the representative textures are shown in this report. Representative textures are the most commonly occurring ones found in soil horizons or layers. Interpretations using texture criteria only consider representative textures. Other textures occurring in the soil are described in the section "Detailed Soil Map Units." Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>250 mm	70-250 mm	4	10	40	200		
	Cm				Pct	Pct					Pct	
85C:												
Gerdrum	0-7	Clay loam	CL	A-7-6, A-6	0	0	92-100	92-100	83-94	66-78	38-43	18-22
	7-20	Clay loam, clay	CL, CH	A-7-6	0	0	93-100	92-100	84-95	67-77	46-56	24-31
	20-60	Clay loam, clay	CL, CH	A-7-6	0	0	93-100	92-100	84-96	67-78	46-58	24-34
	60-85	Clay loam, clay	CL	A-7-6	0	0	93-100	92-100	84-95	67-77	44-54	23-31
	85-120	Clay	CL, CH	A-7-6	0	0	93-100	92-100	85-96	67-78	47-59	25-35
	120-203	Clay	CL, CH	A-7-6	0	0	93-100	92-100	85-96	67-78	48-58	26-33
2564:												
Ulric	0-15	Loam	CL	A-7-6, A-6	0	0	93-96	78-84	68-79	53-62	34-44	12-18
	15-45	Clay loam	CH, CL	A-7-6	0	0	93-96	79-85	69-81	52-63	43-53	22-28
	45-90	Parachannery clay loam, parachannery clay	CH, CL	A-7-6	0	0	100	100	91-99	79-87	44-54	23-31
	90-200	Bedrock	---	---	---	---	---	---	---	---	---	---
Gunsone	0-11	Loam	CL	A-6	0	0	100	96-100	84-91	61-69	32-38	13-16
	11-30	Clay loam	CL	A-7-6, A-6	0	0	100	94-98	84-91	65-72	39-47	19-24
	30-75	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	47-57	25-32
	75-100	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	44-55	24-31
	100-203	Clay loam, paragravelly clay loam	CL	A-7-6, A-6	0	0	100	100	91-97	76-82	39-47	20-26
2571E:												
Cundick	0-12	Gravelly loam	CL, GC	A-6, A-4	0	0	60-74	58-72	51-67	39-53	30-36	10-13
	12-48	Gravelly loam, gravelly clay loam	GC	A-7-6, A-6	0	0	57-69	54-67	48-63	37-50	34-43	14-20
	48-85	Very gravelly loam, gravelly loam	GC	A-6, A-2-6	0	2-8	51-64	48-62	43-58	33-46	30-35	12-16
	85-203	Bedrock	---	---	---	---	---	---	---	---	---	---
Fossilbutte	0-7	Clay loam	CH, CL	A-7-6, A-6	0	0	100	100	90-97	64-74	39-51	18-25
	7-15	Clay loam	CH, CL	A-7-6	0	0	100	100	87-95	65-73	41-52	20-27
	15-80	Gravelly clay loam, clay loam, clay	CH, CL	A-7-6	0	0	100	100	90-97	70-80	45-62	23-36
	80-200	Gravelly clay loam, clay loam, clay	CH, CL	A-7-6	0	0	100	100	90-97	70-80	44-62	22-36
Swiftcreek	0-10	Gravelly loam	GC	A-6, A-2-6	0	0	60-74	58-72	50-65	35-46	33-40	11-16
	10-65	Gravelly loam	GC	A-6, A-2-6	3-8	1-2	61-75	58-74	50-66	35-48	31-39	11-16
	65-203	Gravelly loam, very gravelly loam	GC	A-6, A-2-4	11-19	3-6	51-68	48-66	41-59	29-43	28-35	10-15

Table 13.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>250 mm	70-250 mm	4	10	40	200		
	Cm				Pct	Pct					Pct	
10001:												
Quakenasp	0-8	Moderately decomposed plant material	PT	A-8	0	0	---	---	---	---	---	---
	8-35	Loam	ML, SC	A-7-6, A-6	0	0	74-90	72-90	63-85	48-67	35-46	12-18
	35-85	Clay, clay loam	CH, CL	A-7-6	0	0	77-92	76-91	66-87	50-68	43-55	21-30
	85-200	Clay, clay loam	CH, CL	A-7-6	0	0	100	100	91-98	74-84	42-59	21-35
Ducktail	0-10	Slightly decomposed plant material	PT	A-8	0	0	---	---	---	---	---	---
	10-18	Sandy loam, gravelly sandy loam	SM, GM	A-2-4	0	0	62-83	60-82	44-63	26-39	27-37	5-10
	18-40	Sandy loam, gravelly sandy loam	SM, GM	A-2-4	0	0	62-83	60-82	44-63	26-39	26-37	4-10
	40-200	Gravelly sandy loam, sandy loam	SM, SC, SC-SM	A-6, A-4, A-2-4	0	0-7	71-92	69-92	51-71	30-44	19-30	3-11
10003:												
Mantlemine	0-7	Loam	CL	A-6, A-4	0	0	100	96-100	83-91	61-69	27-32	9-12
	7-24	Loam	CL	A-4, A-6	0	0	100	96-100	83-91	61-69	26-31	10-13
	24-60	Clay loam, loam	CL	A-7-6, A-6	0	0	100	96-100	85-93	65-74	35-44	16-23
	60-80	Clay loam, loam	CL	A-7-6, A-6	0	0	100	96-100	85-93	65-74	34-44	16-23
	80-110	Clay loam, loam	CL	A-6	0	0	100	77-86	69-80	53-63	32-37	13-17
	110-140	Clay loam, loam	CL	A-6	0	0	100	96-100	86-93	66-74	30-38	12-18
	140-203	Loam	CL	A-6	0	0	100	96-100	86-93	66-74	29-37	12-18
Gunsone	0-11	Loam	CL	A-6	0	0	100	96-100	84-91	61-69	32-38	13-16
	11-30	Clay loam	CL	A-7-6, A-6	0	0	100	94-98	84-91	65-72	39-47	19-24
	30-75	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	47-57	25-32
	75-100	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	44-55	24-31
	100-203	Clay loam, paragravelly clay loam	CL	A-7-6, A-6	0	0	100	100	91-97	76-82	39-47	20-26
10004:												
Gunsone	0-11	Loam	CL	A-6	0	0	100	96-100	84-91	61-69	32-38	13-16
	11-30	Clay loam	CL	A-7-6, A-6	0	0	100	94-98	84-91	65-72	39-47	19-24
	30-75	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	47-57	25-32
	75-100	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	44-55	24-31
	100-203	Clay loam, paragravelly clay loam	CL	A-7-6, A-6	0	0	100	100	91-97	76-82	39-47	20-26

Table 13.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>250 mm	70-250 mm	4	10	40	200		
	Cm				Pct	Pct					Pct	
10005:												
Babb	0-25	Loam	ML, CL	A-7-6, A-6	0	0	90-98	90-98	79-91	61-72	32-41	12-15
	25-80	Loam, gravelly loam	GC, CL	A-4, A-6	0	0	63-83	60-82	54-76	41-61	28-36	10-16
	80-130	Loam, gravelly loam	GC, CL	A-6	0	0	71-84	69-83	60-77	46-61	27-37	11-18
	130-203	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	92-96	76-82	46-55	26-33
10006:												
Chickenhill	0-8	Loam	ML, CL	A-7-6, A-6, A-4	0	0	77-91	75-90	66-85	50-68	31-44	10-17
	8-22	Clay loam, loam	CL	A-7-6, A-6	0	0	77-91	76-91	67-86	51-68	31-41	11-19
	22-65	Clay loam, gravelly clay loam, gravelly loam	GC, CL	A-6	0	0	63-83	60-82	53-78	41-62	30-40	11-19
	65-200	Clay loam, clay, silty clay loam	CH, CL	A-7-6	0	0	100	100	93-99	81-87	43-51	24-30
Gunsone	0-11	Loam	CL	A-6	0	0	100	96-100	84-91	61-69	32-38	13-16
	11-30	Clay loam	CL	A-7-6, A-6	0	0	100	94-98	84-91	65-72	39-47	19-24
	30-75	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	47-57	25-32
	75-100	Clay loam, clay	CH, CL	A-7-6	0	0	100	100	91-95	77-82	44-55	24-31
	100-203	Clay loam, paragravelly clay loam	CL	A-7-6, A-6	0	0	100	100	91-97	76-82	39-47	20-26
10007:												
Swiftcreek	0-10	Gravelly loam	GC	A-6, A-2-6	0	0	60-74	58-72	50-65	35-46	33-40	11-16
	10-65	Gravelly loam	GC	A-6, A-2-6	3-8	1-2	61-75	58-74	50-66	35-48	31-39	11-16
	65-203	Gravelly loam, very gravelly loam	GC	A-6, A-2-4	11-19	3-6	51-68	48-66	41-59	29-43	28-35	10-15
10008:												
Cundick	0-12	Gravelly loam	CL, GC	A-6, A-4	0	0	60-74	58-72	51-67	39-53	30-36	10-13
	12-48	Gravelly loam, gravelly clay loam	GC	A-7-6, A-6	0	0	57-69	54-67	48-63	37-50	34-43	14-20
	48-85	Very gravelly loam, gravelly loam	GC	A-6, A-2-6	0	2-8	51-64	48-62	43-58	33-46	30-35	12-16
	85-203	Bedrock	---	---	---	---	---	---	---	---	---	---
Fossilbutte	0-7	Clay loam	CL, CH	A-7-6, A-6	0	0	100	100	90-97	64-74	39-51	18-25
	7-15	Clay loam	CL, CH	A-7-6	0	0	100	100	87-95	65-73	41-52	20-27
	15-80	Gravelly clay loam, clay loam, clay	CH, CL	A-7-6	0	0	100	100	90-97	70-80	45-62	23-36
	80-200	Gravelly clay loam, clay loam, clay	CH, CL	A-7-6	0	0	100	100	90-97	70-80	44-62	22-36

Table 13.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>250 mm	70-250 mm	4	10	40	200		
	Cm				Pct	Pct					Pct	
10012:												
Redsage	0-10	Loam	CL	A-6	0	0	87-94	86-94	76-87	59-69	33-40	13-18
	10-32	Clay loam, loam	CL	A-6	0	0	88-95	88-94	78-88	60-70	32-39	14-19
	32-80	Loam, clay loam, gravelly loam, gravelly clay loam	GC, CL	A-6	0	0	71-84	69-83	61-77	47-61	32-39	13-19
	80-105	Loam, clay loam, gravelly loam, gravelly clay loam	CL	A-6	0	0	75-87	73-86	65-80	50-64	32-39	13-19
	105-203	Loam, clay loam	CL	A-7-6, A-6	0	0	89-95	88-95	78-88	60-70	34-41	16-21
Rootel	0-9	Loam	CL	A-6	0	0	78-85	77-84	68-78	52-62	30-38	11-16
	9-40	Gravelly loam	GC, CL	A-6	0	0	65-77	62-76	55-70	42-56	28-38	11-18
	40-75	Gravelly loam	GC, CL	A-4, A-6	0	3-6	70-77	68-75	60-70	46-55	26-36	9-17
	75-95	Clay loam, loam	CL	A-6	0	0	100	100	89-93	68-74	30-38	12-18
	95-203	Bedrock	---	---	---	---	---	---	---	---	---	---
10014:												
Absher	0-9	Clay loam	CL	A-6, A-7-6	0	0	100	100	95-99	75-81	40-45	19-22
	9-35	Clay loam, clay	CL, CH	A-7-6	0	0	100	100	89-95	72-78	49-56	26-32
	35-75	Clay loam, clay	CL, CH	A-7-6	0	0	100	100	89-95	72-78	49-56	27-32
	75-105	Clay loam, clay	CL, CH	A-7-6	0	0	100	100	96-100	77-85	45-57	24-33
	105-203	Clay loam, clay	CL, CH	A-7-6	0	0	100	100	96-100	77-85	45-57	24-33
Bearbou	0-11	Loam	CL	A-6	0	0	100	100	90-94	72-78	34-40	13-16
	11-40	Clay loam, loam	CL	A-7-6, A-6	0	0	100	100	90-94	72-78	35-43	15-20
	40-70	Clay loam, clay	CL, CH	A-7-6	0	0	100	100	91-95	72-78	47-57	25-32
	70-160	Clay loam, clay	CL, CH	A-7-6	0	0	100	100	91-95	72-78	47-57	25-33
	160-203	Clay	CH	A-7-6	0	0	100	100	88-92	71-77	50-60	28-35

Table 14.—Physical Soil Properties

(Sand, silt, and clay values are shown either as a range or as a representative value. Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	Cm	Pct	Pct	Pct	g/cc	um/sec	Cm/cm	Pct	Pct
85C:									
Gerdrum	0-7	25-35	36-44	28-32	1.15-1.25	4.0-14.0	0.15-0.19	3.0-4.1	0.5-1.0
	7-20	25-35	27-31	37-45	1.30-1.40	0.4-1.4	0.13-0.17	5.1-7.4	0.5-1.0
	20-60	25-35	25-29	38-48	1.30-1.40	0.0-0.4	0.13-0.17	4.9-8.0	0.0-0.5
	60-85	25-35	27-31	37-45	1.30-1.40	0.0-0.4	0.13-0.17	4.5-7.0	0.0-0.5
	85-120	25-35	23-27	40-50	1.30-1.40	0.4-1.4	0.13-0.17	5.0-8.2	0.0-0.5
	120-203	25-35	23-27	41-49	1.30-1.40	0.4-1.4	0.10-0.14	5.2-7.9	0.0-0.5
2564:									
Ulric	0-15	30-40	38-46	20-26	1.20-1.30	4.0-14.0	0.16-0.20	1.8-2.9	2.0-4.0
	15-45	30-40	25-31	33-40	1.30-1.40	1.4-4.0	0.15-0.19	3.7-6.3	1.0-2.0
	45-90	15-25	35-43	37-45	1.30-1.40	0.4-1.4	0.09-0.13	3.2-5.5	0.0-0.5
	90-200	---	---	---	---	0.0-2.0	---	---	---
Gunsone	0-11	35-45	34-42	20-24	1.15-1.25	4.0-14.0	0.16-0.20	2.1-2.9	1.0-2.0
	11-30	30-40	30-36	29-35	1.30-1.40	4.0-14.0	0.16-0.20	3.4-5.6	0.5-1.0
	30-75	20-30	31-37	37-45	1.20-1.30	0.4-1.4	0.14-0.18	5.9-8.0	0.5-1.0
	75-100	20-30	31-37	37-45	1.30-1.40	0.4-1.4	0.09-0.13	4.5-7.0	0.0-0.5
	100-203	20-30	36-44	32-38	1.40-1.50	1.4-4.0	0.09-0.13	2.3-4.5	0.0-0.5
2571E:									
Cundick	0-12	30-40	43-51	16-20	1.15-1.25	4.0-14.0	0.13-0.17	1.2-2.0	2.0-3.0
	12-48	30-40	34-42	24-30	1.30-1.40	4.0-14.0	0.12-0.16	1.7-2.9	1.0-2.0
	48-85	30-40	37-48	22-26	1.40-1.50	4.0-14.0	0.09-0.13	1.1-1.9	0.0-0.5
	85-203	---	---	---	---	0.0-4.0	---	---	---
Fossilbutte	0-7	30-50	23-35	27-35	1.15-1.25	4.0-14.0	0.18-0.22	3.3-6.2	1.0-3.0
	7-15	30-50	20-40	30-38	1.30-1.40	4.0-14.0	0.17-0.21	3.5-6.5	1.0-2.0
	15-80	20-40	23-33	35-50	1.20-1.30	0.4-1.4	0.12-0.16	4.6-9.9	0.5-1.0
	80-200	20-40	23-33	35-50	1.30-1.40	0.4-1.4	0.12-0.16	4.3-9.9	0.5-1.0
Swiftcreek	0-10	40-50	29-35	20-25	1.15-1.25	4.0-14.0	0.13-0.17	1.4-2.3	2.0-3.0
	10-65	40-50	28-34	21-27	1.30-1.40	4.0-14.0	0.12-0.16	1.1-2.1	1.0-2.0
	65-203	40-50	28-34	21-27	1.40-1.50	4.0-14.0	0.08-0.12	0.6-1.5	0.0-0.5
10001:									
Quakenasp	0-8				0.10-0.30	42.0-141.0	0.15-0.45	---	55-90
	8-35	30-40	37-49	18-26	1.15-1.25	4.0-14.0	0.17-0.21	1.7-3.4	3.0-5.0
	35-85	30-40	21-33	33-43	1.40-1.50	1.4-4.0	0.15-0.19	3.4-5.9	1.0-2.0
	85-200	20-30	27-39	35-50	1.30-1.40	0.4-1.4	0.15-0.19	3.5-7.2	0.0-0.5
Ducktail	0-10				0.10-0.30	42.0-705.0	0.15-0.45	---	65-95
	10-18	55-65	24-30	10-16	1.25-1.35	14.0-42.0	0.12-0.16	0.5-1.3	3.0-5.0
	18-40	55-65	24-30	10-16	1.25-1.35	14.0-42.0	0.12-0.16	0.5-1.3	3.0-5.0
	40-200	55-65	23-27	11-19	1.50-1.60	14.0-42.0	0.09-0.13	0.3-1.3	0.0-1.0

Table 14.—Physical Soil Properties—Continued

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	Cm	Pct	Pct	Pct	g/cc	um/sec	Cm/cm	Pct	Pct
10003:									
Mantlemine	0-7	35-45	40-48	14-18	1.15-1.25	4.0-14.0	0.16-0.20	1.4-1.9	1.0-2.0
	7-24	35-45	39-47	15-19	1.15-1.25	4.0-14.0	0.15-0.19	1.5-2.0	0.5-1.0
	24-60	30-40	33-41	24-32	1.30-1.40	4.0-14.0	0.16-0.20	3.0-4.6	0.5-1.0
	60-80	30-40	32-40	25-33	1.30-1.40	4.0-14.0	0.16-0.20	2.7-4.4	0.3-0.8
	80-110	30-40	35-43	24-28	1.40-1.50	4.0-14.0	0.13-0.17	1.7-2.6	0.0-0.5
	110-140	30-40	36-44	22-28	1.40-1.50	4.0-14.0	0.15-0.19	1.8-3.0	0.0-0.5
	140-203	30-40	38-46	20-26	1.40-1.50	4.0-14.0	0.15-0.19	1.9-3.2	0.0-0.5
Gunsone	0-11	35-45	34-42	20-24	1.15-1.25	4.0-14.0	0.16-0.20	2.1-2.9	1.0-2.0
	11-30	30-40	30-36	29-35	1.30-1.40	4.0-14.0	0.16-0.20	3.4-5.6	0.5-1.0
	30-75	20-30	31-37	37-45	1.20-1.30	0.4-1.4	0.14-0.18	5.9-8.0	0.5-1.0
	75-100	20-30	31-37	37-45	1.30-1.40	0.4-1.4	0.09-0.13	4.5-7.0	0.0-0.5
	100-203	20-30	36-44	32-38	1.40-1.50	1.4-4.0	0.09-0.13	2.3-4.5	0.0-0.5
10004:									
Gunsone	0-11	35-45	34-42	20-24	1.15-1.25	4.0-14.0	0.16-0.20	2.1-2.9	1.0-2.0
	11-30	30-40	30-36	29-35	1.30-1.40	4.0-14.0	0.16-0.20	3.4-5.6	0.5-1.0
	30-75	20-30	31-37	37-45	1.20-1.30	0.4-1.4	0.14-0.18	5.9-8.0	0.5-1.0
	75-100	20-30	31-37	37-45	1.30-1.40	0.4-1.4	0.09-0.13	4.5-7.0	0.0-0.5
	100-203	20-30	36-44	32-38	1.40-1.50	1.4-4.0	0.09-0.13	2.3-4.5	0.0-0.5
10005:									
Babb	0-25	30-40	41-49	18-22	1.15-1.25	4.0-14.0	0.17-0.21	1.8-2.8	2.0-4.0
	25-80	30-40	38-46	20-26	1.30-1.40	4.0-14.0	0.12-0.16	1.2-2.3	0.3-0.8
	80-130	30-40	39-47	18-26	1.40-1.50	4.0-14.0	0.12-0.16	1.3-2.9	0.0-0.5
	130-203	20-30	30-38	37-45	1.30-1.40	0.4-1.4	0.15-0.19	5.0-7.2	0.0-0.5
10006:									
Chickenhill	0-8	25-45	37-49	18-26	1.25-1.35	4.0-14.0	0.16-0.20	1.2-2.7	2.0-4.0
	8-22	25-45	35-47	20-28	1.30-1.40	4.0-14.0	0.14-0.18	1.4-2.8	1.0-2.0
	22-65	25-45	33-45	22-30	1.30-1.40	4.0-14.0	0.12-0.16	1.1-2.4	0.5-1.0
	65-200	15-25	35-47	36-42	1.30-1.40	1.4-4.0	0.15-0.19	2.6-4.6	0.0-0.5
Gunsone	0-11	35-45	34-42	20-24	1.15-1.25	4.0-14.0	0.16-0.20	2.1-2.9	1.0-2.0
	11-30	30-40	30-36	29-35	1.30-1.40	4.0-14.0	0.16-0.20	3.4-5.6	0.5-1.0
	30-75	20-30	31-37	37-45	1.20-1.30	0.4-1.4	0.14-0.18	5.9-8.0	0.5-1.0
	75-100	20-30	31-37	37-45	1.30-1.40	0.4-1.4	0.09-0.13	4.5-7.0	0.0-0.5
	100-203	20-30	36-44	32-38	1.40-1.50	1.4-4.0	0.09-0.13	2.3-4.5	0.0-0.5
10007:									
Swiftcreek	0-10	40-50	29-35	20-25	1.15-1.25	4.0-14.0	0.13-0.17	1.4-2.3	2.0-3.0
	10-65	40-50	28-34	21-27	1.30-1.40	4.0-14.0	0.12-0.16	1.1-2.1	1.0-2.0
	65-203	40-50	28-34	21-27	1.40-1.50	4.0-14.0	0.08-0.12	0.6-1.5	0.0-0.5
10008:									
Cundick	0-12	30-40	43-51	16-20	1.15-1.25	4.0-14.0	0.13-0.17	1.2-2.0	2.0-3.0
	12-48	30-40	34-42	24-30	1.30-1.40	4.0-14.0	0.12-0.16	1.7-2.9	1.0-2.0
	48-85	30-40	37-48	22-26	1.40-1.50	4.0-14.0	0.09-0.13	1.1-1.9	0.0-0.5
	85-203	---	---	---	---	0.0-4.0	---	---	---

Table 14.—Physical Soil Properties—Continued

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	Cm	Pct	Pct	Pct	g/cc	um/sec	Cm/cm	Pct	Pct
10008:									
Fossilbutte-----	0-7	30-50	23-35	27-35	1.15-1.25	4.0-14.0	0.18-0.22	3.3-6.2	1.0-3.0
	7-15	30-50	20-40	30-38	1.30-1.40	4.0-14.0	0.17-0.21	3.5-6.5	1.0-2.0
	15-80	20-40	23-33	35-50	1.20-1.30	0.4-1.4	0.12-0.16	4.6-9.9	0.5-1.0
	80-200	20-40	23-33	35-50	1.30-1.40	0.4-1.4	0.12-0.16	4.3-9.9	0.5-1.0
10012:									
Redsage---------	0-10	30-40	38-46	21-26	1.15-1.25	4.0-14.0	0.15-0.19	2.2-3.2	1.0-2.0
	10-32	30-40	36-44	22-28	1.35-1.45	4.0-14.0	0.14-0.18	2.3-3.4	0.5-1.0
	32-80	30-40	34-42	24-30	1.40-1.50	4.0-14.0	0.12-0.16	1.6-2.9	0.0-0.5
	80-105	30-40	34-42	24-30	1.40-1.50	4.0-14.0	0.12-0.16	1.7-3.0	0.0-0.5
	105-203	30-40	33-41	25-31	1.40-1.50	4.0-14.0	0.15-0.19	2.4-3.8	0.0-0.5
Rootel----------	0-9	30-40	40-48	18-24	1.15-1.25	4.0-14.0	0.14-0.18	1.6-2.7	1.0-2.0
	9-40	30-40	39-47	18-26	1.40-1.50	4.0-14.0	0.11-0.15	1.3-2.8	0.5-1.0
	40-75	30-40	39-47	18-26	1.40-1.50	4.0-14.0	0.11-0.15	1.0-2.3	0.0-0.5
	75-95	30-40	36-44	22-28	1.40-1.55	4.0-14.0	0.13-0.17	1.7-2.9	0.0-0.5
	95-203	---	---	---	---	0.0-2.0	---	---	---
10014:									
Absher----------	0-9	25-35	35-45	28-32	1.15-1.25	4.0-14.0	0.15-0.19	3.5-4.3	1.0-2.0
	9-35	25-85	24-32	39-45	1.30-1.40	0.0-0.4	0.15-0.19	6.2-7.8	0.5-1.0
	35-75	25-35	24-32	39-45	1.30-1.40	0.0-0.4	0.10-0.14	6.3-7.9	0.5-1.0
	75-105	25-35	25-33	36-46	1.25-1.35	0.4-1.4	0.13-0.17	5.2-8.1	0.0-0.5
	105-203	25-35	25-33	36-46	1.25-1.35	0.4-1.4	0.14-0.18	5.2-8.1	0.0-0.5
Bearbou---------	0-11	25-35	43-53	20-24	1.15-1.25	4.0-14.0	0.16-0.20	2.2-3.0	2.0-3.0
	11-40	25-35	40-48	23-29	1.35-1.45	4.0-14.0	0.16-0.20	2.7-3.9	1.0-2.0
	40-70	25-35	25-33	37-45	1.35-1.45	0.4-1.4	0.15-0.19	6.4-8.5	0.5-1.0
	70-160	25-35	24-32	38-46	1.40-1.50	0.4-1.4	0.15-0.19	6.1-8.7	0.0-0.5
	160-203	25-35	21-27	42-50	1.30-1.40	0.4-1.4	0.15-0.19	7.0-9.7	0.0-0.5

Table 15.—Erosion Properties

(Entries under "Erosion factors" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer)

Map unit symbol and soil name	Depth (cm)	Erosion factors			Wind erodibility group	Wind erodibility index
		Kw	Kf	T		
85C:						
Gerdrum	0-7	.32	.32	2	4L	86
	7-20	.28	.28			
	20-60	.28	.28			
	60-85	.32	.32			
	85-120	.24	.24			
	120-203	.24	.24			
161.						
Rock outcrop						
2564:						
Badland.						
Ulric	0-15	.32	.32	3	4L	86
	15-45	.24	.24			
	45-90	.32	.32			
	90-200	---	---			
Gunsone	0-11	.37	.37	5	6	48
	11-30	.32	.32			
	30-75	.28	.28			
	75-100	.28	.28			
	100-203	.32	.32			
2571E:						
Cundick	0-12	.17	.32	2	5	56
	12-48	.17	.32			
	48-85	.20	.43			
	85-203	---	---			
Fossilbutte	0-7	.28	.28	5	6	48
	7-15	.28	.28			
	15-80	.28	.28			
	80-200	.28	.28			
Swiftcreek	0-10	.17	.28	5	5	56
	10-65	.15	.28			
	65-203	.10	.32			
10001:						
Quakenasp	0-8	---	---	5	6	48
	8-35	.28	.28			
	35-85	.24	.24			
	85-200	.28	.28			
Ducktail	0-10	---	---	5	5	56
	10-18	.10	.15			
	18-40	.15	.20			
	40-200	.24	.24			

Table 15.—Erosion Properties—Continued

Map unit symbol and soil name	Depth (cm)	Erosion factors			Wind erodibility group	Wind erodibility index
		Kw	Kf	T		
10003:						
Mantlemine	0-7	.32	.32	5	5	56
	7-24	.43	.43			
	24-60	.32	.32			
	60-80	.32	.32			
	80-110	.37	.37			
	110-140	.37	.37			
	140-203	.37	.37			
Gunsone	0-11	.37	.37	5	6	48
	11-30	.32	.32			
	30-75	.28	.28			
	75-100	.28	.28			
	100-203	.32	.32			
10004:						
Gunsone	0-11	.37	.37	5	6	48
	11-30	.32	.32			
	30-75	.28	.28			
	75-100	.28	.28			
	100-203	.32	.32			
10005:						
Babb	0-25	.28	.28	5	6	48
	25-80	.24	.37			
	80-130	.28	.37			
	130-203	.28	.28			
10006:						
Chickenhill	0-8	.28	.28	5	4L	86
	8-22	.32	.32			
	22-65	.24	.37			
	65-200	.32	.32			
Gunsone	0-11	.37	.37	5	6	48
	11-30	.32	.32			
	30-75	.28	.28			
	75-100	.28	.28			
	100-203	.32	.32			
10007:						
Swiftcreek	0-10	.17	.28	5	5	56
	10-65	.15	.28			
	65-203	.10	.32			
10008:						
Cundick	0-12	.17	.32	2	5	56
	12-48	.17	.32			
	48-85	.20	.43			
	85-203	---	---			
Fossilbutte	0-7	.28	.28	5	6	48
	7-15	.28	.28			
	15-80	.28	.28			
	80-200	.28	.28			
10012:						
Redsage	0-10	.37	.37	5	4L	86
	10-32	.37	.37			
	32-80	.24	.32			
	80-105	.32	.32			
	105-203	.32	.32			

Table 15.—Erosion Properties—Continued

Map unit symbol and soil name	Depth (cm)	Erosion factors			Wind erodibility group	Wind erodibility index
		Kw	Kf	T		
10012:						
Rootel	0-9	.37	.37	3	4L	86
	9-40	.24	.37			
	40-75	.24	.37			
	75-95	.37	.37			
	95-203	---	---			
10014:						
Absher	0-9	.32	.32	2	6	48
	9-35	.28	.28			
	35-75	.28	.28			
	75-105	.32	.32			
	105-203	.32	.32			
Bearbou	0-11	.32	.32	5	6	48
	11-40	.37	.37			
	40-70	.28	.28			
	70-160	.28	.28			
	160-203	.24	.24			

Table 16.—Total Soil Carbon

(This table displays soil organic carbon (SOC) and soil inorganic carbon (SIC) in kilograms per square meter to a depth of 2 meters or to the representative top depth of any kind of bedrock or any cemented soil horizon. SOC and SIC are reported on a volumetric whole soil basis, corrected for representative rock fragments indicated in the database. SOC is converted from horizon soil organic matter of the fraction of the soil less than 2 mm in diameter. If soil organic matter indicated in the database is NULL, SOC is assumed to be zero. SIC is converted from horizon calcium carbonate content fraction of the soil less than 2 mm in diameter. If horizon calcium carbonate indicated in the database is NULL, SIC is assumed to be zero. A weighted average of all horizons is used in the calculations. Only major components of a map unit are displayed in this table)

Map unit symbol, component name, and component percent	SOC	SIC
	kg/m^2	kg/m^2
85C:		
Gerdrum (90%)	5	58
161:		
Rock outcrop (100%)	0	0
2564:		
Badland (45%)	0	0
Ulric (30%)	7	15
Gunsone (15%)	7	35
2571E:		
Cundick (45%)	5	16
Fossilbutte (25%)	12	23
Swiftcreek (15%)	8	80
10001:		
Quakenasp (50%)	21	36
Ducktail (35%)	22	66
10003:		
Mantlemine (50%)	7	31
Gunsone (30%)	7	35
10004:		
Gunsone (80%)	7	35
10005:		
Babb (80%)	9	24
10006:		
Chickenhill (45%)	8	25
Gunsone (35%)	7	35
10007:		
Swiftcreek (75%)	8	80

Table 16.—Total Soil Carbon—Continued

Map unit symbol, component name, and component percent	SOC	SIC
	kg/m^2	kg/m^2
10008:		
Cundick (40%)	5	16
Fossilbutte (35%)	12	23
10012:		
Redsage (65%)	5	49
Rootel (30%)	3	20
10014:		
Absher (60%)	7	11
Bearbou (25%)	10	23

Table 17.—Soil Features

(See text for definitions of terms used in this table. Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
		cm	cm				
85C:							
Gerdrum	Natric	15-25	45-85	Noncemented	Low	High	High
Redsage	No restriction	---	---	---	Moderate	High	Moderate
2564:							
Ulric	Paralithic bedrock	75-105	95-125	Weakly cemented	Low	High	Moderate
Gunsone	No restriction	---	---	---	Low	High	High
Mantlemine	No restriction	---	---	---	Moderate	High	Moderate
Redsage	No restriction	---	---	---	Moderate	Moderate	Moderate
2571E:							
Cundick	Lithic bedrock	75-95	108-128	Very strongly cemented	Moderate	Moderate	Low
Fossilbutte	No restriction	---	---	---	Low	High	Moderate
Swiftcreek	No restriction	---	---	---	Moderate	Moderate	Low
Reppart	Paralithic bedrock	100-200	---	Weakly cemented	Moderate	Moderate	Low
10001:							
Quakenasp	No restriction	---	---	---	Moderate	High	Low
Ducktail	No restriction	---	---	---	Moderate	Moderate	Low
Swiftcreek	No restriction	---	---	---	Moderate	Moderate	Low
10003:							
Mantlemine	No restriction	---	---	---	Moderate	Moderate	Low
Gunsone	No restriction	---	---	---	Low	High	High
Dunlap	Paralithic bedrock	30-40	163-173	Moderately cemented	Moderate	Moderate	Low
Redsage	No restriction	---	---	---	Moderate	Moderate	Moderate

Table 17.—Soil Features—Continued

Map unit symbol and soil name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
		cm	cm				
10004:							
Gunsone	No restriction	---	---	---	Low	High	High
Mantlemine	No restriction	---	---	---	Moderate	High	Moderate
Whitesage	No restriction	---	---	---	Moderate	High	Moderate
10005:							
Babb	No restriction	---	---	---	Moderate	High	Low
Cundick	Lithic bedrock	75-95	108-128	Very strongly cemented	Moderate	Moderate	Low
Swiftcreek	No restriction	---	---	---	Moderate	Moderate	Low
10006:							
Chickenhill	No restriction	---	---	---	Moderate	Moderate	Moderate
Gunsone	No restriction	---	---	---	Low	High	High
Mantlemine	No restriction	---	---	---	Moderate	High	Moderate
Swiftcreek	No restriction	---	---	---	Moderate	Moderate	Low
10007:							
Swiftcreek	No restriction	---	---	---	Moderate	Moderate	Low
Lithic Ustorthents	Lithic bedrock	30-45	158-168	Very strongly cemented	Moderate	Moderate	Low
Marigold	Lithic bedrock	75-95	108-128	Very strongly cemented	Moderate	Moderate	Low
10008:							
Cundick	Lithic bedrock	75-95	108-128	Very strongly cemented	Moderate	Moderate	Low
Fossilbutte	No restriction	---	---	---	Low	High	Moderate
Ettienridge	Lithic bedrock	70-90	110-130	Strongly cemented	Moderate	High	High
Reppart	Paralithic bedrock	100-200	---	Weakly cemented	Moderate	Moderate	Low
Lyonsbridge	No restriction	---	---	---	Moderate	High	Moderate

Table 17.—Soil Features—Continued

Map unit symbol and soil name	Restrictive layer				Potential for frost action	Risk of corrosion	
	Kind	Depth to top	Thickness	Hardness		Uncoated steel	Concrete
		cm	cm				
10012:							
Redsage	No restriction	---	---	---	Moderate	Moderate	Moderate
Rootel	Paralithic bedrock	85-105	98-118	Moderately cemented	Moderate	Moderate	Moderate
10014:							
Absher	Natric	7-11	54-78	Noncemented	Low	High	High
Bearbou	No restriction	---	---	---	High	High	Moderate
Dillon	No restriction	---	---	---	Moderate	High	Moderate

Table 18.—Water Features

(See text for definitions of terms used in this table. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Cm	Cm	Cm				
85C:									
Gerdrum	D								
		Jan-Dec	---	---	---	---	None	---	None
2564:									
Ulric	C								
		Jan-Dec	---	---	---	---	None	---	None
Gunsone	C								
		Jan-Dec	---	---	---	---	None	---	None
2571E:									
Cundick	C								
		Jan-Dec	---	---	---	---	None	---	None
Fossilbutte	C								
		Jan-Dec	---	---	---	---	None	---	None
Swiftcreek	B								
		Jan-Dec	---	---	---	---	None	---	None
10001:									
Quakenasp	C								
		Jan-Dec	---	---	---	---	None	---	None
Ducktail	A								
		Jan-Dec	---	---	---	---	None	---	None
10003:									
Mantlemine	B								
		Jan-Dec	---	---	---	---	None	---	None
Gunsone	C								
		Jan-Dec	---	---	---	---	None	---	None
10004:									
Gunsone	C								
		Jan-Dec	---	---	---	---	None	---	None
10005:									
Babb	B								
		Jan-Apr	---	---	---	---	None	---	None
		May	130	>200	---	---	None	---	None
		June	130	>200	---	---	None	---	None
		July	130	>200	---	---	None	---	None
		Aug-Dec	---	---	---	---	None	---	None
10006:									
Chickenhill	C								
		Jan-Dec	---	---	---	---	None	---	None
Gunsone	C								
		Jan-Dec	---	---	---	---	None	---	None

Table 18.—Water Features—Continued

Map symbol and soil name	Hydrologic group	Month	Water table		Ponding			Flooding	
			Upper limit	Lower limit	Surface water depth	Duration	Frequency	Duration	Frequency
			Cm	Cm	Cm				
10007:									
Swiftcreek------	B								
		Jan-Dec	---	---	---	---	None	---	None
10008:									
Cundick---------	C								
		Jan-Dec	---	---	---	---	None	---	None
Fossilbutte-----	C								
		Jan-Dec	---	---	---	---	None	---	None
10012:									
Redsage---------	B								
		Jan-Dec	---	---	---	---	None	---	None
Rootel----------	C								
		Jan-Dec	---	---	---	---	None	---	None
10014:									
Absher----------	D								
		Jan-Mar	---	---	---	---	None	---	None
		April	105	>200	---	---	None	---	None
		May	105	>200	---	---	None	---	None
		June	105	>200	---	---	None	---	None
		July-Dec	---	---	---	---	None	---	None
Bearbou---------	C/D								
		Jan-Mar	---	---	---	---	None	---	None
		April	11	>200	---	---	None	Brief (2 to 7 days)	Occasional
		May	11	>200	---	---	None	Brief (2 to 7 days)	Occasional
		June	11	>200	---	---	None	Brief (2 to 7 days)	Occasional
		July-Dec	---	---	---	---	None	---	None

Table 19.—Chemical Soil Properties

(Absence of an entry indicates that data were not estimated)

Map symbol and soil name	Depth	Cation-exchange capacity	Effective cation-exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	Cm	meq/100 g	meq/100 g	pH	Pct	Pct	mmhos/cm	
85C:								
Gerdrum	0-7	21.0-22.8	---	8.4-8.8	5-10	0	2.0-4.0	5-12
	7-20	25.6-29.4	---	8.4-8.8	10-20	0	4.0-8.0	5-12
	20-60	23.5-30.7	---	8.7-9.3	10-20	0-1	4.0-8.0	13-15
	60-85	22.3-28.1	---	8.6-9.0	15-25	1-3	4.0-8.0	15-20
	85-120	24.0-30.7	---	8.4-8.8	15-25	2-4	4.0-8.0	5-12
	120-203	24.0-30.7	---	8.4-8.8	15-25	2-4	8.0-16.0	5-12
2564:								
Ulric	0-15	17.0-20.3	---	7.6-8.0	5-10	0	0.0-2.0	0-3
	15-45	24.8-28.8	---	7.8-8.4	5-10	0	0.0-2.0	3-7
	45-90	22.9-28.8	---	8.0-8.4	10-20	0-1	4.0-8.0	3-7
	90-200	---	---	---	---	---	---	---
Gunsone	0-11	16.6-19.8	---	7.0-7.4	0	0	0.0-2.0	0
	11-30	21.6-25.5	---	7.4-7.8	2-4	0	0.0-2.0	0-3
	30-75	26.9-31.4	---	8.4-8.8	2-4	0	2.0-4.0	5-12
	75-100	22.9-28.8	---	8.2-8.6	10-20	2-4	8.0-16.0	5-12
	100-203	20.0-24.9	---	8.2-8.6	10-20	1-3	8.0-16.0	5-12
2571E:								
Cundick	0-12	13.9-16.5	---	8.2-8.6	5-10	0	0.0-2.0	3-7
	12-48	18.1-20.8	---	8.4-8.8	10-20	0	0.0-2.0	3-7
	48-85	13.5-16.9	---	8.4-8.8	15-25	0	0.0-2.0	3-7
	85-203	---	---	---	---	---	---	---
Fossilbutte	0-7	21.5-27.1	---	7.0-7.8	0-2	0	0.0-2.0	0
	7-15	22.8-28.1	---	7.4-8.2	2-4	0	0.0-2.0	0
	15-80	25.6-34.6	---	7.4-8.2	2-4	0	0.0-2.0	0
	80-200	24.9-33.3	---	7.6-8.4	5-15	0-1	2.0-4.0	0-3
Swiftcreek	0-10	15.5-17.3	---	7.9-8.5	15-25	0	0.0-2.0	1-5
	10-65	13.6-17.0	---	8.2-8.8	25-35	0	0.0-2.0	3-7
	65-203	10.3-14.7	---	8.2-8.8	35-45	0	0.0-2.0	3-7
10001:								
Quakenasp	0-8	---	30.0-60.0	4.5-6.5	0	0	0	0-1
	8-35	15.7-21.9	---	6.6-7.2	0	0	0.0-2.0	0-1
	35-85	24.2-29.5	---	8.0-8.6	5-15	0	0.0-2.0	3-7
	85-200	21.7-31.3	---	8.0-8.6	10-20	0	0.0-2.0	3-7
Ducktail	0-10	---	30.0-60.0	4.5-6.5	0	0	0.0-2.0	0-1
	10-18	9.3-12.8	---	7.8-8.4	5-15	0	0.0-2.0	0-3
	18-40	9.3-12.0	---	7.8-8.4	10-20	0	0.0-2.0	0-3
	40-200	6.9-10.5	---	7.8-8.4	15-35	0	0.0-2.0	0-3
10003:								
Mantlemine	0-7	12.0-15.5	---	7.0-7.4	0	0	0.0-2.0	0-3
	7-24	12.5-15.8	---	7.0-7.4	0	0	0.0-2.0	0-3
	24-60	19.0-25.3	---	7.0-7.4	0	0	0.0-2.0	0-3
	60-80	18.5-23.6	---	7.8-8.2	5-10	0	0.0-2.0	0-3
	80-110	14.2-17.6	---	8.4-8.8	20-30	0	0.0-2.0	5-12
	110-140	13.5-18.3	---	8.4-8.8	15-25	0	0.0-2.0	5-12
	140-203	14.2-19.0	---	8.2-8.6	5-10	0	0.0-2.0	3-7

Table 19.—Chemical Soil Properties—Continued

Map symbol and soil name	Depth	Cation-exchange capacity	Effective cation-exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	Cm	meq/100 g	meq/100 g	pH	Pct	Pct	mmhos/cm	
10003:								
Gunsone	0-11	16.6-19.8	---	7.0-7.4	0	0	0.0-2.0	0
	11-30	21.6-25.5	---	7.4-7.8	2-4	0	0.0-2.0	0-3
	30-75	26.9-31.4	---	8.4-8.8	2-4	0	2.0-4.0	5-12
	75-100	22.9-28.8	---	8.2-8.6	10-20	2-4	8.0-16.0	5-12
	100-203	20.0-24.9	---	8.2-8.6	10-20	1-3	8.0-16.0	5-12
10004:								
Gunsone	0-11	16.6-19.8	---	7.0-7.4	0	0	0.0-2.0	0
	11-30	21.6-25.5	---	7.4-7.8	2-4	0	0.0-2.0	0-3
	30-75	26.9-31.4	---	8.4-8.8	2-4	0	2.0-4.0	5-12
	75-100	22.9-28.8	---	8.2-8.6	10-20	2-4	8.0-16.0	5-12
	100-203	20.0-24.9	---	8.2-8.6	10-20	1-3	8.0-16.0	5-12
10005:								
Babb	0-25	15.5-19.1	---	7.0-7.4	0	0	0.0-2.0	0
	25-80	12.9-16.4	---	8.4-8.8	20-30	0	0.0-2.0	3-7
	80-130	12.9-19.0	---	8.2-8.6	5-10	0	0.0-2.0	3-7
	130-203	24.7-33.5	---	8.2-8.6	0	0	0.0-2.0	5-10
10006:								
Chickenhill	0-8	14.7-19.1	---	7.8-8.4	10-20	0	0.0-2.0	0-3
	8-22	15.8-20.1	---	7.8-8.4	10-20	0	0.0-2.0	0-3
	22-65	15.4-18.8	---	7.8-8.6	15-30	0	0.0-2.0	3-7
	65-200	23.4-30.2	---	8.0-8.6	2-4	0-1	2.0-4.0	3-7
Gunsone	0-11	16.6-19.8	---	7.0-7.4	0	0	0.0-2.0	0
	11-30	21.6-25.5	---	7.4-7.8	2-4	0	0.0-2.0	0-3
	30-75	26.9-31.4	---	8.4-8.8	2-4	0	2.0-4.0	5-12
	75-100	22.9-28.8	---	8.2-8.6	10-20	2-4	8.0-16.0	5-12
	100-203	20.0-24.9	---	8.2-8.6	10-20	1-3	8.0-16.0	5-12
10007:								
Swiftcreek	0-10	15.5-17.3	---	7.9-8.5	15-25	0	0.0-2.0	1-5
	10-65	13.6-17.0	---	8.2-8.8	25-35	0	0.0-2.0	3-7
	65-203	10.3-14.7	---	8.2-8.8	35-45	0	0.0-2.0	3-7
10008:								
Cundick	0-12	13.9-16.5	---	8.2-8.6	5-10	0	0.0-2.0	3-7
	12-48	18.1-20.8	---	8.4-8.8	10-20	0	0.0-2.0	3-7
	48-85	13.5-16.9	---	8.4-8.8	15-25	0	0.0-2.0	3-7
	85-203	---	---	---	---	---	---	---
Fossilbutte	0-7	21.5-27.1	---	7.0-7.8	0-2	0	0.0-2.0	0
	7-15	22.8-28.1	---	7.4-8.2	2-4	0	0.0-2.0	0
	15-80	25.6-34.6	---	7.4-8.2	2-4	0	0.0-2.0	0
	80-200	24.9-33.3	---	7.6-8.4	5-15	0-1	2.0-4.0	0-3
10012:								
Redsage	0-10	17.3-20.1	---	8.0-8.4	5-10	0	0.0-2.0	3-7
	10-32	16.9-21.0	---	8.0-8.4	5-10	0	0.0-2.0	3-7
	32-80	14.8-19.0	---	8.4-8.8	15-25	0	2.0-4.0	5-12
	80-105	14.8-19.0	---	8.4-8.8	15-25	0	2.0-4.0	5-12
	105-203	16.7-21.9	---	8.0-8.4	10-20	0	0.0-2.0	3-7
Rootel	0-9	15.1-18.6	---	8.0-8.4	5-10	0	0.0-2.0	3-7
	9-40	14.7-19.6	---	8.0-8.4	5-10	0	2.0-4.0	3-7
	40-75	11.6-16.9	---	8.4-8.8	15-25	0	2.0-4.0	5-12
	75-95	13.5-18.3	---	8.4-8.8	15-25	0	2.0-4.0	5-12
	95-203	---	---	---	---	---	---	---

Table 19.—Chemical Soil Properties—Continued

Map symbol and soil name	Depth	Cation-exchange capacity	Effective cation-exchange capacity	Soil reaction	Calcium carbonate	Gypsum	Salinity	Sodium adsorption ratio
	Cm	meq/100 g	meq/100 g	pH	Pct	Pct	mmhos/cm	
10014:								
Absher	0-9	21.5-24.7	---	8.4-8.8	2-4	0	4.0-8.0	3-7
	9-35	27.5-30.7	---	9.0-9.6	5-10	1-3	---	15-25
	35-75	27.5-31.4	---	8.9-9.5	2-4	0	8.0-16.0	13-17
	75-105	23.5-31.3	---	8.6-9.0	2-4	0	4.0-8.0	3-7
	105-203	23.5-31.3	---	8.0-8.4	2-4	0	2.0-4.0	3-7
Bearbou	0-11	17.0-20.1	---	7.4-7.8	0-2	0	2.0-4.0	0-3
	11-40	18.7-22.6	---	7.6-8.2	2-5	0	0.0-2.0	0
	40-70	26.2-30.7	---	7.8-8.4	5-10	0	0.0-2.0	0-3
	70-160	24.0-30.7	---	8.0-8.6	5-10	0	0.0-2.0	3-7
	160-203	25.7-32.5	---	8.0-8.6	5-15	0	0.0-2.0	3-7

Table 20.—Taxonomic Classification of the Soils

(An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics that are outside the range of the series)

Soil name	Family or higher taxonomic class
Absher	Fine, smectitic, frigid Leptic Torrertic Natrustalfs
Babb	Fine-loamy, mixed, superactive Calcic Haplocryolls
Bearbou	Fine, smectitic, frigid Typic Endoaquolls
Chickenhill	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
Cundick	Fine-loamy, mixed, superactive Ustic Haplocryalfs
Ducktail	Coarse-loamy, mixed, superactive Typic Haplocryolls
Fossilbutte	Fine, smectitic Vertic Haplocryalfs
Gerdrum	Fine, smectitic, frigid Torrertic Natrustalfs
Gunsone	Fine, smectitic, frigid Torrertic Haplustalfs
Mantlemine	Fine-loamy, mixed, superactive, frigid Calcidic Haplustalfs
Quakenasp	Fine, smectitic Vertic Argicryolls
Redsage	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
Rootel	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
*Swiftcreek	Fine-loamy, mixed, superactive Ustic Haplocryepts
Swiftcreek	Fine-loamy, mixed, superactive, frigid Typic Haplustepts
Ulric	Fine, smectitic, frigid Torrertic Haplustalfs

Table 21.—Soil Classification Key

(An asterisk in the first column indicates a taxadjunct to the series. A taxadjunct has soil properties that lie outside the range of the named series. See text for a description of those characteristics that are routside the range of the series)

ORDER Suborder Great Group Subgroup Series or Higher Category	
ALFISOLS	
Ustalfs	
Haplustalfs	
Aridic Haplustalfs	
Dunlap	Loamy, mixed, superactive, frigid, shallow Aridic Haplustalfs
Calcidic Haplustalfs	
Mantlemine	Fine-loamy, mixed, superactive, frigid Calcidic Haplustalfs
Torrertic Haplustalfs	
Gunsone	Fine, smectitic, frigid Torrertic Haplustalfs
Ulric	Fine, smectitic, frigid Torrertic Haplustalfs
Inceptic Haplustalfs	
Marigold	Fine-loamy, mixed, superactive, frigid Inceptic Haplustalfs
Natrustalfs	
Leptic Torrertic Natrustalfs	
Absher	Fine, smectitic, frigid Leptic Torrertic Natrustalfs
Torrertic Natrustalfs	
Gerdrum	Fine, smectitic, frigid Torrertic Natrustalfs
Cryalfs	
Haplocryalfs	
Vertic Haplocryalfs	
Fossilbutte	Fine, smectitic Vertic Haplocryalfs
Ustic Haplocryalfs	
Cundick	Fine-loamy, mixed, superactive Ustic Haplocryalfs
ENTISOLS	
Orthents	
Ustorthents	
Lithic Ustorthents	
Lithic Ustorthents	Loamy, mixed, superactive, calcareous, frigid Lithic Ustorthents
INCEPTISOLS	
Cryepts	
Calcicryepts	
Ustic Calcicryepts	
Reppart	Fine-loamy, carbonatic Ustic Calcicryepts
Lyonsbridge	Fine-loamy, mixed, superactive Ustic Calcicryepts
Ettienridge	Loamy-skeletal, carbonatic Ustic Calcicryepts
Haplocryepts	
Ustic Haplocryepts	
*Swiftcreek	Fine-loamy, mixed, superactive Ustic Haplocryepts
Ustepts	
Calciustepts	
Aridic Calciustepts	
Chickenhill	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
Redsage	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
Rootel	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
Whitesage	Fine-loamy, mixed, superactive, frigid Aridic Calciustepts
Haplustepts	
Oxyaquic Haplustepts	
*Dillon	Fine-loamy, mixed, superactive, frigid Oxyaquic Haplustepts
Typic Haplustepts	
Swiftcreek	Fine-loamy, mixed, superactive, frigid Typic Haplustepts

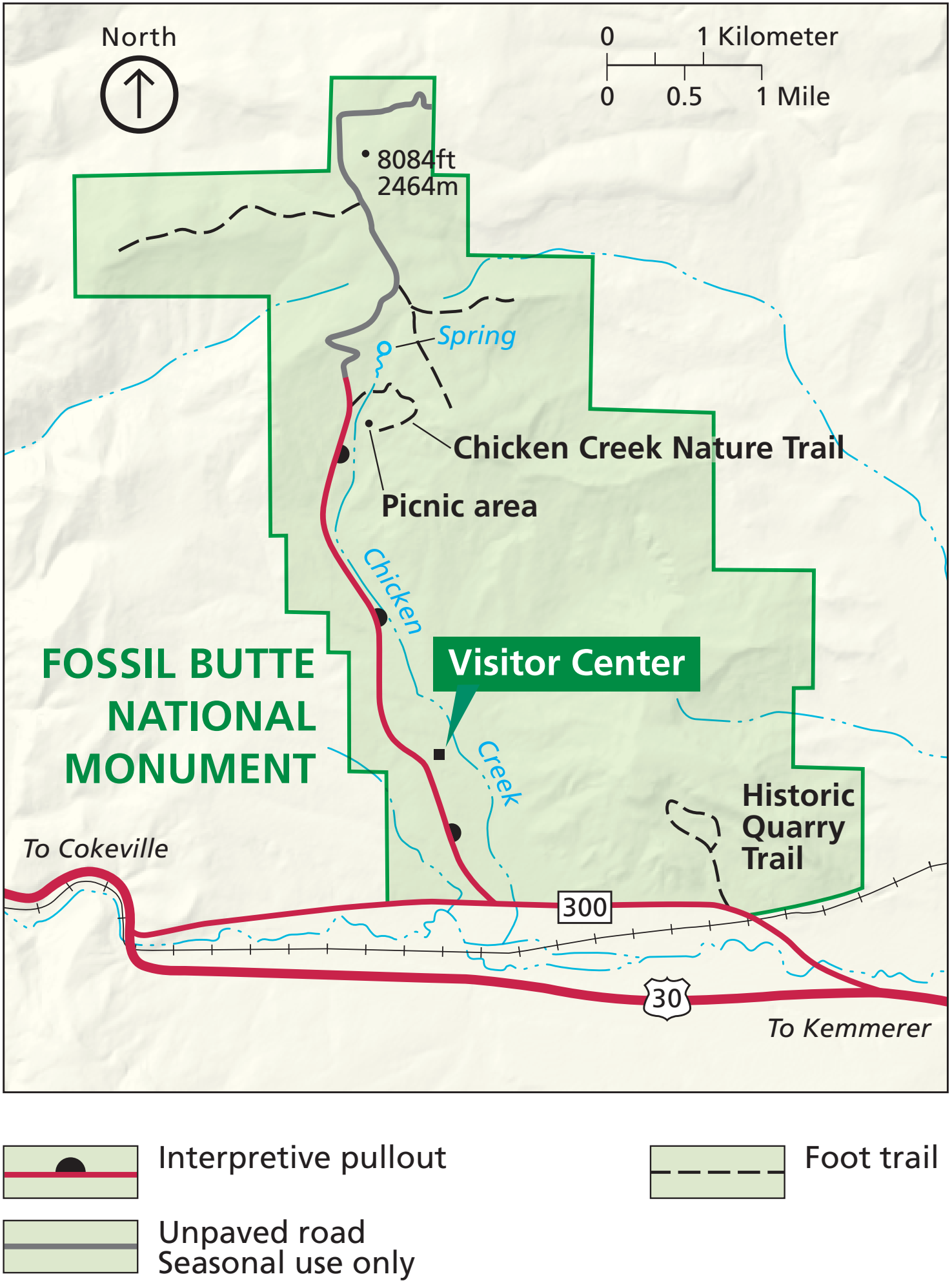
Table 21.—Soil Classification Key—Continued

ORDER Suborder Great Group Subgroup Series or Higher Category
MOLLISOLS
Aquolls
Endoaquolls
Typic Endoaquolls
Bearbou----------Fine, smectitic, frigid Typic Endoaquolls
Cryolls
Argicryolls
Vertic Argicryolls
Quakenasp----------Fine, smectitic Vertic Argicryolls
Haplocryolls
Calcic Haplocryolls
Babb----------Fine-loamy, mixed, superactive Calcic Haplocryolls
Typic Haplocryolls
Ducktail----------Coarse-loamy, mixed, superactive Typic Haplocryolls

Accessibility Statement

The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The USDA Target Center can convert USDA information and documents into alternative formats, including Braille, large print, video description, diskette, and audiotape. For more information, visit the TARGET Center's Web site (http://www.targetcenter.dm.usda.gov/) or call (202) 720-2600 (Voice/TTY).


North
0
1 Kilometer
0
0.5
1 Mile
8084ft
2464m
Spring
Chicken Creek Nature Trail
Picnic area
Chicken
Creek
FOSSIL BUTTE
NATIONAL
MONUMENT
Visitor Center
Historic
Quarry
Trail
To Cokeville
300
30
To Kemmerer
Interpretive pullout
Foot trail
Unpaved road
Seasonal use only

U.S. DEPARTMENT OF AGRICULTURE

NATURAL RESOURCES CONSERVATION SERVICE

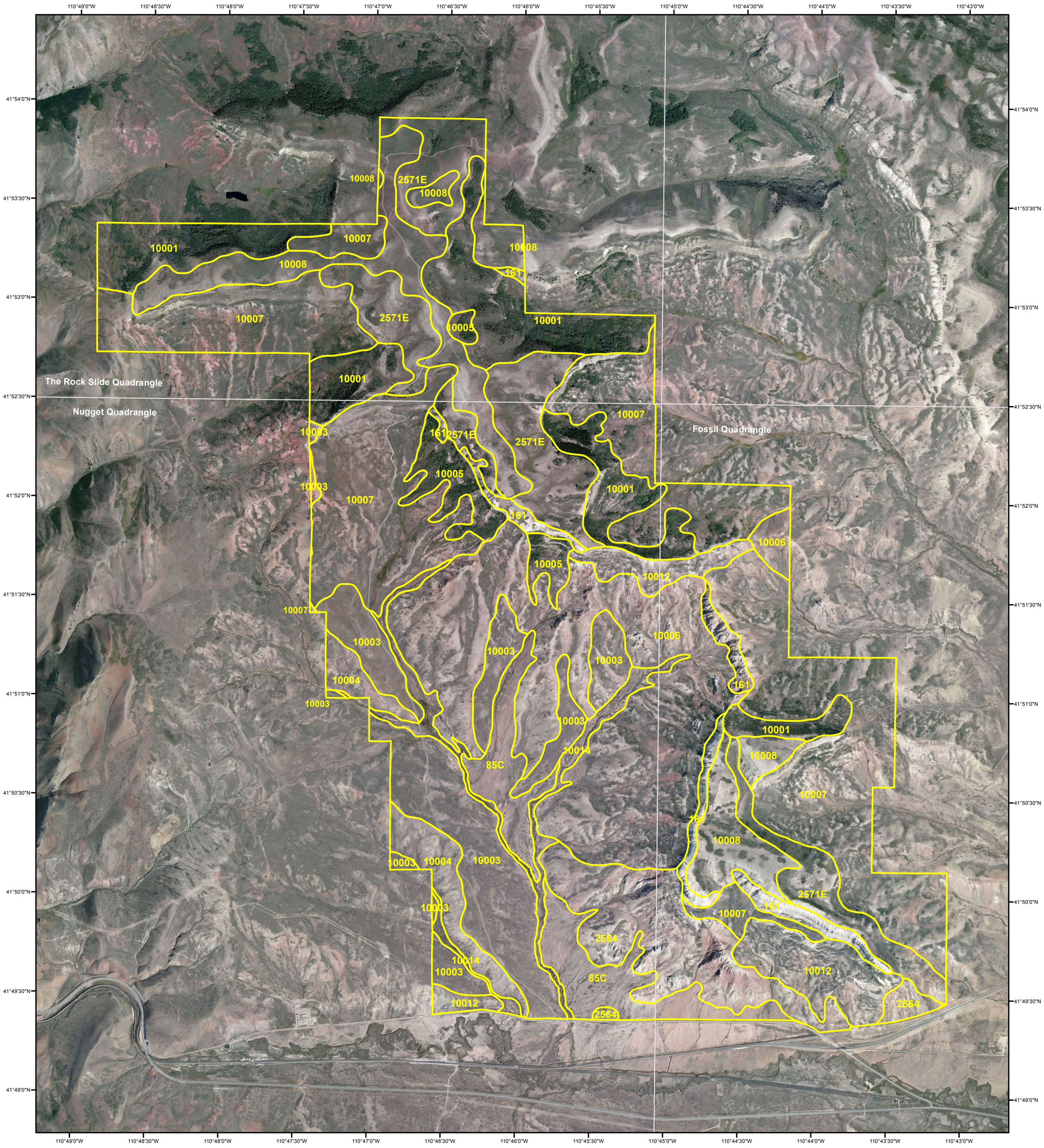
MAP UNIT LEGEND
FOSSIL BUTTE NATIONAL MONUMENT, WYOMING

U.S. DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE

SYMBOL	NAME
85C	Gerdrum clay loam, 3 to 10 percent slopes
161	Rock outcrop
2564	Badland-Ulric-Gunsone complex, 15 to 30 percent slopes
2571E	Cundick-Fossilbutte-Swiftcreek complex, 6 to 20 percent slopes
10001	Quakenasp-Ducktail complex, 20 to 80 percent slopes
10003	Mantlemine-Gunsone complex, 3 to 15 percent slopes
10004	Gunsone loam, 3 to 15 percent slopes
10005	Babb loam, 10 to 25 percent slopes
10006	Chickenhill-Gunsone complex, 10 to 30 percent slopes
10007	Swiftcreek gravelly loam, 15 to 50 percent slopes
10008	Cundick-Fossilbutte complex, 1 to 6 percent slopes
10012	Redsage-Rootel complex, 8 to 35 percent slopes
10014	Absher-Bearbou complex, 0 to 3 percent slopes

SOIL SURVEY OF FOSSIL BUTTE NATIONAL MONUMENT
LINCOLN COUNTY, WYOMING
THE ROCK SLIDE, NUGGET AND FOSSIL QUADRANGLES
SHEET NUMBER 1 OF 1



This soil survey was compiled by the U.S. Department of Agriculture, Natural Resources Conservation Service, at the request of the Department of the Interior, National Park Service. Base maps are 2011 Bing Maps one-foot resolution imagery. A 2012 National Park Service boundary was used. Soil information was derived from USDA/NRCS Soil Survey Geographic (SSURGO) database for Fossil Butte National Monument.Universal Transverse Mercator Zone 12 North, North American Datum of 1983 (NAD83).

Natural Resources Conservation Service

0 0.25 0.5 1
Miles

1:24,000